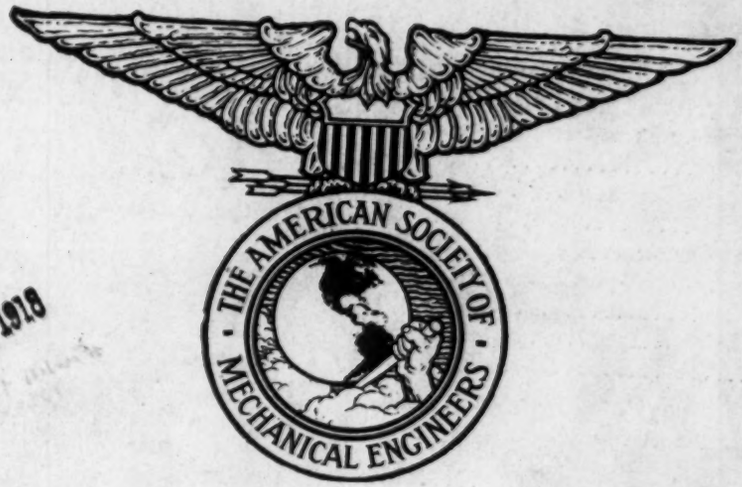
THE · JOURNAL · OF · THE AMERICAN · SOCIETY · OF MECHANICAL · ENGINEERS



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THE NEW BY-LAWS GOVERNING SECTIONS OF THE A.S.M.E.: WHAT THEY PERMIT AND ENCOURAGE

By LOUIS C. MARBURG, NEW YORK, N. Y.

Member, Committee on Local Sections

THE task has been assigned to me to speak on the new Local Sections By-Laws of The American Society of Mechanical Engineers. I will say something regarding their history and will try to point out a few paragraphs that appear of interest in connection with the routine operation of the Local Sections. I will consider mainly, however, those characteristics of the new by-laws which seem to show a new spirit and which recognize modern tendencies in the engineering profession and elsewhere; and will also devote some consideration to these tendencies themselves and to the activities they suggest.

In the Technical Section of this issue of The Journal appear the first papers before the Local Sections of the Society this season.

The Sections papers will be continued in the April and May issues, and then again in the issues following the Spring Meeting. Several good papers are on hand.

In connection with these Sections papers it is of interest to note that the Local Sections, acting on the suggestion of the Committee on Local Sections, are now appointing papers and research sub-committees to develop the relations between the Sections and the Meetings and Publication Committees of the Society.

This is a significant move—it means that the way is being paved for the complete nationalization of the proceedings of the Society, so that these proceedings will truly constitute a record of mechanical engineering progress in America.

Previous to the acceptance of these new by-laws, the Constitution, By-Laws and Rules of the Society contained but scant reference to any Local Section activity. There was a paragraph in the Constitution permitting the formation of professional sections and geographical groups, and there were rules regulating both in a rather indefinite way, and taking little account of the great difference between them. The Local Sections movement increased rather independently of these rules; and it might seem that more elaborate by-laws were quite unnecessary. The Committee on Local Sections felt, however, that a certain amount of uniformity in matters of routine was advisable and that, furthermore, the experience of older and successful Sections might be made available, in the form of by-laws, to new Sections. Therefore it appointed some time last year a sub-committee consisting of Prof. Walter Rautenstrauch and myself to prepare a draft for new by-laws. This draft was submitted to the Local Sections delegates a year ago for criticism and suggestions; it was modified in accordance with some of the ideas expressed at that time and submitted to the Council. After being referred to the Committee on Constitution and By-Laws for proper codification and comment, and after some joint work between this Committee and your committee, these by-laws finally emerged and were passed by the Council at its October 1917 meeting. If any details do not meet with the Sections' approval, it should be remembered that all laws are compromises, except those made by an autocrat, which generally please but one person—the autocrat himself.

The New By-Laws and Their Interpretation

The by-laws naturally contain several paragraphs pertaining to matters of routine, such as the procedure in forming a new Section, the definition of territory and membership, the personnel and duties of the local committees, the method and time of election, contributions on the part of the parent Society and the use of such contributions, the use of uniform stationery, etc., all of which aim at unifying Sections procedure, to the strength of the organization.

More interesting than these is the paragraph on "Local Section members," granting to each Section the right to include a new class of membership, if it so desires—local members of the Section who are not members of the parent Society. Any dues collected from such local members belong to the Section, and the parent Society has no control over their disbursement. Opinions will vary as to the advisability of permitting this class of local membership,—they will vary mainly on account of the difference in problems that Sections have to meet and owing to the difference in local conditions. Some Sections have such members, others may find it useful to have them, others may not. The decision rests with the Sections themselves.

Useful Activities of the Sections

On Section activities the new by-laws contain a number of paragraphs. Here, of course, there is a great deal to say, for the activity of the Sections is necessarily the activity of the Society. Papers shall be read, that is a matter of course. It has always been the main function of our Society and there is no new suggestion in this. Attention, however, should be called to the paragraph suggesting that such papers, after being read before the Sections, be submitted to the Committee on Meetings and to the Publication Committee for possible further use. It is urged that this practice be generally adopted. It will furnish to The Journal much valuable material. It will also tend to improve the quality of papers read before Sections, because the author of a well-prepared address will be assured of a larger audience, particularly if his paper is accepted for a general meeting of the Society and published in the Transactions.

Another recognized activity consists in social functions and the fostering of acquaintanceship among engineers, an important and a very useful part of the Sections work.

The Keynote of All Sections Work—Coöperation

Foremost, however, of all the activities mentioned in the by-laws appears to be coöperation. Coöperation with other

Address delivered before the Conference of Local Sections Delegates of the Society at the Annual Meeting of The American Society of Mechanical Engineers, New York, December 1917.

engineering organizations, be they local engineering societies or sections of other national societies, and coöperation with other organizations of whatever kind, in any enterprise having the approval of the Section. We cannot too earnestly recommend the coöperation with other local sections and the affiliation with local engineering societies or clubs. The experience in St. Louis, Philadelphia, Milwaukee and other cities has been so extremely satisfactory that it should encourage similar combinations in other localities. The recognition of coöperation in other than strictly professional work, which is accorded in the paragraphs referred to, is a radical innovation in the policy of our Society, but more will be said on this particular point.

By-Laws Constructive, Not Obstructive

Perhaps after my introductory remarks about a new spirit expressed in our By-Laws, this short résumé has proven disappointing. Perhaps a casual glance over these by-laws does not show anything so strikingly novel. Perhaps also, and probably, some real or contemplated activity in some of the Sections has already been along the lines suggested in all the paragraphs on Sections activity. Let me express right here and most emphatically, that these by-laws are not believed to point the way to something never thought of before, they do not contain a single new and brilliant thought; but they do, it is believed, take proper cognizance of changing ideas and of newer tendencies. They do not stand in the way of certain aims which should be encouraged and which are welcomed by the engineer of vision and by the firm believer that the engineering profession has higher ideas than perfection in the calculation of stresses and the design of machinery and structures.

By-Laws Recognize Modern Tendencies

In discussing more fully the spirit of the new by-laws and the degree to which they show recognition of modern tendencies, we must take these tendencies themselves into consideration.

First, these by-laws seem to express a spirit, not only of democracy, but of a particular kind of democracy. Democracy, which in its political sense means majority rule, we have of course always had in our Society whenever the members were sufficiently interested to use their power. But even if members everywhere could be induced to take an equal amount of interest in the affairs of our Society, majority rule alone would not yet be satisfactory. Majority rule of a certain kind is unendurable and more tyrannical than the rule of many an autocrat. If vital questions affecting a small community are decided by the majority of fifteen or twenty million voters in a huge country, it is small consolation for this community to know that a decision against its wishes and its vital interests has been reached by the rules of democracy. Not only may injustice result from having a government so far removed from those it governs, but there may arise a feeling of helplessness and a lack of interest. Bertrand Russell says in one of his books: "The modern great state is harmful from its vastness and the resulting sense of individual helplessness. Even in a democracy, all questions except a very few are decided by a small number of officials and eminent men; and even the few questions which are left to the popular vote are decided by a diffused mass-psychology, not by individual initiative."

Sections Require, and Retain, Self-Determination

It is this feeling of helplessness, this suppression of the individual initiative, which we must guard against even in an organization having only 9000 voters instead of fifteen or twenty or thirty millions. Engineers in districts remote from New York require an organization nearer to themselves than the national society, nearer not only in distance but in interest. It is to this need that the whole Sections movement owes its existence, and it is self-evident that, in order to do their best, such local organizations require the greatest degree of self-determination and the greatest freedom from outside interference consistent with harmonious coöperation with the parent Society. Sections must manage their own affairs; they will know their local needs and conditions, and as long as they do not commit the national society by any of their actions, little control from headquarters will be needed; and, no doubt, affairs will be handled properly and to the best interests of the Sections themselves.

Let nobody fear that the position of the parent society will be impaired by this policy. Let nobody fear sectarianism. The danger of our present world organization lies not in too little centralization of power but in the excess of such centralized power. Government too far removed from the individual voter is offensive, in fact, it is dangerous. Let us realize this, let us have strong sections taking interest in local affairs. Home rule, which to so great an extent has been responsible for the success of our national government, must be the order of the day in the world that is to come. Let us have it in our Society and in our Section management.

Coöperation and More Coöperation—What It Can Do

As stated, the By-Laws suggest coöperation, coöperating mainly with other engineering groups like local sections of other national societies and local engineering societies, but also with other organizations of whatever kind for the furtherance of objects benefiting the engineering profession or the community at large. Coöperation with other engineering societies or sections, aside from being a necessity in communities where our Sections are too small, lends variety to meetings, helps to secure better papers, and avoids duplication of work in many instances. But mainly it is to be recommended because engineers of different branches should come in closer touch, should know and understand each other better, each other's work and problems and difficulties. They should discuss more the joint interests of our profession, our aims and hopes and ideals. They should plan more for joint work, of which there is plenty.

There is standardization, so far almost exclusively done by individual engineering societies. It seems that a great deal could be done by having national societies coöperate to establish national standards, instead of A.I.E.E. standards, S.A.E. standards, A.S.M.E. standards, and whatever they all may be.

And do not let us stop at the national frontiers. Let us join with foreign engineers to establish international standards. We are learning much just now regarding the lack of international uniformity, when we are doing so much work for the European nations who have different standards, yes, who even have different systems of measurements. Some beginning has been made, and just now the International Aircraft Standards Board in Washington is doing useful work.

But not only for war is such standardization desirable, it is important also in the work of peace. We have entered the group of nations which export industrial products to a large extent. Our weakness in manufacturing is special work; our

strength, quantity manufacture of standardized products. International standardization would be of greater benefit to us than to almost any other nation.

Coöperation with other engineers will also help us to increase and to exert the influence of the engineering profession. Strong local engineering societies, to which are affiliated all the sections of the national societies, are the best guardians of the engineer's local interests. Coöperation with non-engineering organizations will also increase the influence of engineers and will make available to the community their services and advice on subjects on which their knowledge is greater and their judgment better than that of the average citizen.

How far a section or any engineering society should go in taking up subjects not closely related to engineering or the engineering profession, it is of course impossible to advise. When, however, an engineering society takes an official stand, it should be only on a matter affecting the engineer as such, but regardless as to whether it is engineering work or economic and social legislation.

Broadens the Engineer, Brings Him in Touch with Affairs

Hand in hand with cooperation goes the broadening of the engineer. Cooperation widens our horizon, and a wider horizon in turn enables us to coöperate better. I want to make a strong plea for a broader scope of the engineer's interests, for a broader education. I mean not only broader school and college education. I want to plead especially that the engineer, after graduation, continue not only study and interest in engineering subjects other than his own, but also in economic and social questions, which so vitally affect our work. The knowledge we acquire in college is valuable, but the best thing we can take with us from college into after life, as James Bryce once expressed it, is the taste for knowledge. Do not let us lose that, do not let the young man lose it when he comes from college and when he necessarily must specialize to a great extent in order to get a start.

No period in the world's history has been so under the influence of engineering work and development, as the present; during no previous period has the engineer himself depended to such an extent on economic and social conditions as now. Is it then not logical to say that the engineer should and must now be in closer touch with the legislation and administration of country, state, and city than ever before?

The world is moving fast just now. When we are fixing prices of food, of fuel, of raw and partly finished products, when we consider control and even operation of our railroads by our Government, we certainly have adopted economic ideas not in favor heretofore. When the Conference of Organized Labor is addressed by the President of the United States, and when the executive council of this same organized labor files a resolution outlining a foreign policy for the nation and insisting upon participation in the peace conference by labor delegates, certainly changes are taking place in our country.

And with it all, these changes seem but small compared with those across the ocean. Any class of men so vitally affected by economic and labor conditions as the engineers must study these developments; anybody but him who lives in dreamland, must reckon with them. Do not deceive yourselves by thinking that except for the one great revolution the changes going on are not so vital and that things may get back to where they were before. Try to compare today with yesterday. If you can discover a milestone in the past ten or fifteen years ago which indicates conditions as they were, compare and you will realize the journey we have taken. You are so accustomed to plotting curves. Plot, so to speak, your curves of economic and social changes with the abscissa time. See how they changed from past to present and try to divine where they will lead in future.

The question of the standing enjoyed by our profession will solve itself if we but broaden and coöperate. In the past the engineer has specialized, and with ability and strenuous effort he has succeeded in doing great things. But too often it has been someone else who coördinated and directed and interpreted his efforts and who, therefore, received, and perhaps to a considerable degree deserved, the credit for success in an enterprise. I am not one of those who believe that advertising the engineering profession is the panacea for these ills. True, the general public had for a long time misunderstood the engineers' work; it had considered him quite generally a man without imagination. As to the general willingness, however, at this time, to concede the engineer a prominent place, there can be little doubt. The war has furnished all the advertising necessary for the engineer.

The Desired Result Within Reach

It may be felt that I have strayed far from Sections By-Laws, that I have gone roaming into fields rather unconnected with our work as Sections and Sections Committee. But the new by-laws are an expression of modern tendencies; the committees that framed them and the men who passed them in the Council were under their spell, consciously or subconsciously. And as I see our by-laws, they suggest and they encourage more democracy within our Society, coöperation and broader interests, a stronger and more worth-while engineering profession, and service to our country and the world. Certainly when we go dreaming on these subjects there is no limit to our imagination and no measure for the enthusiasm and inspiration which we may derive.

A conference of Ohio engineering societies was held at Columbus January 29. The meeting resulted in the formation of a permanent organization named the Association of Ohio Technical Societies, with Clyde T. Morris, professor of civil engineering of Ohio State University, as president and C. E. Drayer of Cleveland as secretary. All local societies and local sections of the national societies in the state, twelve in all, were represented, except one which has since indicated its desire to be included, so that the representation now includes all.

Resolutions were adopted endorsing the ten cardinal principles adopted by the Committee on Engineering Coöperation at its conference last March; urging local societies to endeavor to have at least one engineer named on any board having to do with the expenditure of public funds where engineering experience would be of assistance; and endorsing the report of the Inter-society Relations Committee of the Cleveland Engineering Society suggesting that the national societies consider as a prerequisite to membership that a candidate show membership in an accredited local society. Employment, participation in civic affairs and statutory regulation of engineering practice were discussed, the last at length.

All delegates seemed to recognize that regulation by law of the practice of engineering is coming, and that if engineers do not recognize this situation and do the lawmaking themselves, somebody else will.

PROBLEMS OF CRANKSHAFT DESIGN

A Paper in Which Mathematical Deductions from Examples from Prevailing Practice Are Utilized to Derive Factors of Safety and Other Specific Values

By OTTO M. BURKHARDT,[1] BUFFALO, N. Y.

GASOLINE engines, of the kind at present produced in large quantities for airplanes and motor vehicles, may turn over at 3000 r.p.m. or faster. The forces necessary to induce and maintain these speeds, as well as other forces closely associated with high speeds, are numerous; but with a particular object in mind, this paper will be confined to the three most important groups of forces—the pressures due to the gaseous mixture, the inertia forces, and the centrifugal forces. The smooth running and the life of an engine depend mainly on these three factors.

The reciprocating masses linked to the crankshaft will be considered as one mass concentrated at one point in the axis of the cylinder. This simplification implies that the inertia forces are, like the gas pressures, acting primarily in the direction of the cylinder axis, a condition that permits arithmetical addition of both groups of forces. To the same category belongs another group of forces which, according to a well-known law, has its origin in the angularity of the connecting rod. The different component forces have been determined in respect to two engines of equal capacity for 24 crank positions. These positions are uniformly spaced at intervals of 30 deg.

TABLE 1 DIMENSIONS AND WEIGHTS FOR ENGINES OF SIMILAR DESIGN

	Six-Cylinder	Twelve-Cylinder
Cylinder bore, in.	3.75	3.00
Stroke, in. (=bore × 1.667)	6.25	5.00
Weight of reciprocating parts, lb. (one cylinder)	4.07	2.60
Weight of rotating parts, lb. (one cylinder)	2.40	1.93
Weight of rotating parts, lb. (two cylinders)		3.86

and comprise two revolutions, which constitute one complete cycle in case of four-stroke-cycle engines.

Corresponding components when combined as resultant forces and graphically represented in magnitude and direction, yield irregular characteristic diagrams with which every engine designer should acquaint himself.

As subjects for investigation, medium-size six- and twelve-cylinder engines, both of the same cylinder volume, were chosen. Both engines are supposed to be similar in design and up to the same standard of construction. Some particulars relating to these engines are given in Table 1.

Fig. 1 is a force diagram pertaining to the six-cylinder engine. The concentric circle is a graphical representation of the centrifugal forces acting on the crankpin at a speed of 2700 r.p.m. The combined gas and inertia forces as above referred to are represented by the irregular polygons.

For instance, O-3 of this diagram represents the magnitude and direction of the combined gas and inertia forces if the crankpin is in position 3, that is, 60 deg. from the top dead center. For one complete cycle the different strokes are represented as follows:

Power stroke, by forces O-1 to O-7
Exhaust stroke, by O-7 to O-13
Suction stroke, by O-13 to O-19
Compression stroke, by O-19 to O-1.

To obtain a clear picture of the total forces acting on a crankpin, we must combine both diagrams as follows: O-1 of the polygon with O-1 of the concentric-circle diagram, and so on. This yields the diagram shown in Fig. 2, which represents the magnitude and direction of the resultant forces acting on the crankpin of a six-cylinder vertical engine.

The combined gas and inertia forces for one unit of a twelve-cylinder engine and the corresponding centrifugal forces are diagrammatically represented in Fig. 3. We observe that these forces are much smaller but quite analogous to those given in Fig. 1. The combination of the gas and inertia forces with the centrifugal forces yields the diagram shown in Fig. 4, which represents in magnitude and direction the resultant forces per cylinder acting on the crankpin of a twelve-cylinder engine. It must be borne in mind, however, that in the case of the engine under consideration, two single-cylinder engines are acting on one crankpin. We have, therefore, to superimpose two diagrams so that their vertical axes include an angle of 60 deg., as in Fig. 5. The crank positions 1 to 24 in the diagram are plotted according to the clockwise rotation of the crankshaft. The distinction between the right- and left-hand block of cylinders is made through the indices R and L by similarly viewing the engine. According to the conventional sequence of firing, we obtain: 1L, 6R, 5L, 2R, 3L, 4R, 6L, 1R, 2L, 5R, 4L, 3R. From this we see that the engine on the right is in phase 420 deg. behind the other, or (what amounts to the same thing) 300 deg. ahead of it. It follows that we must combine force O-1L due to the left-hand engine with force O-11R due to the right-hand engine and so on. Properly carried out for all simultaneous acting forces, this yields a diagram, Fig. 6, representing in magnitude and direction the forces acting on the crankpin of a twelve-cylinder V-type engine.

It is difficult to neutralize by balance weights the effect on the crankpin of the forces shown in Figs. 2 and 6. The reason is that the centrifugal forces involved are due to a mass performing a relative motion. That is to say, the rotating mass of the connecting rod does not rotate truly about its own center but turns relatively to another mass, which turns about a center of its own.

In order to be entirely effective under such circumstances, balance weights would in turn have to perform relative motions. This introduces extra friction and complication. Balance weights for this effect are quite feasible, however, for six-cylinder engines, but they are almost an impossibility for twelves. The diagrams reveal the fact that the forces are smallest in a horizontal direction. This suggests that the oil holes in the crankpin should be placed at right angles to the radial lines through the center of the pin. The preferable direction would be opposite to that of rotation. To prevent the oil from escaping, a labyrinth should be cut in the bushing bearing surface, where the forces are a minimum.

[1] Mathematical Research Engineer, Pierce-Arrow Motor Car Company.

Abstract of paper presented at a meeting of the Engineering Society of Buffalo, Automotive Section, October 24, 1917.

A glance at Figs. 2 and 6 shows that the difference in the loads acting on the crankpin of either engine is not marked. The maximum load in the case of the twelve is 4040 lb., and in the case of the six, 4795 lb. The difference between the two is $18\frac{3}{4}$ per cent of the former. These loads increase approximately as the square of the speed. If then the twelve-cylinder engine runs at 2940 r.p.m., it is subject to the same maximum load as is the six when running at 2700 r.p.m. Mention is made of this because it is generally found in practice that a car with a twelve-cylinder engine is geared so that the engine runs at a slightly higher speed than a six-cylinder engine would be made to run.

The life of a crankshaft bearing depends largely on the magnitude of the mean pressure resulting from the various loads acting during one complete cycle, and this has been found to be 15 per cent smaller with the six than with the twelve. It is an axiom in bearing design that a certain permissible load per unit of bearing surface should not be exceeded. Nevertheless we shall not content ourselves with speaking of maximum or mean loads exclusively, a mistake which is committed by altogether too many engineers who endeavor to design high-speed-engine bearings with a certain specific load as their only guide.

Designers also should not lose sight of the fact that intermittent loads such as are encountered in high-speed internal-combustion engines affect bearings differently than does a steady load. It is well understood that a load acting continually in one direction is likely to cause lubrication difficulties. To what extent a bearing will behave well under the effect of a steady load is shown by an experiment made by Professor Goodman, who states that he has had a journal running for weeks with a surface velocity of 4 ft. per sec. under a steady load of 2 tons (4480 lb.) per sq. in., the journal being kept at a temperature of 110 deg. fahr. by a stream of water forced through it. It is evident that bearing loads of this magnitude are hardly permissible under conditions where the load is subject to frequent and abrupt changes in direction unless an unusual amount of attention is being given to the maintenance of a certain running clearance by frequent adjustments. Therefore it is advisable under ordinary circumstances either to avoid fluctuations in load or to reduce the specific bearing pressure. For instance, the maximum permissible load on crankpins of slow-running stationary gas engines and locomotives is about 1500 lb. per sq. in. of bearing surface.

Furthermore, it is essential for an engineer to bear in mind the well-known fundamental empirical law of fluid motion,[1] namely, that the resistance to sliding is due to the shearing of the fluid film and is consequently a function of the velocity of shearing, the viscosity of the fluid, and the shearing area. This law has proved useful for solving lubrication problems and conforms with the well-known experiments by Beauchamp Tower[2] which showed that the frictional resistance of a journal at a constant temperature is directly proportional to the square root of the rubbing velocity and is independent of the total load.

The laws of friction and carrying power thus far mentioned assume the presence of an oil film of not less than a certain thickness between the journal and the bearing. Without this film no bearing can be safe against undue abrasion. To maintain this much-desired oil film the designer should as far as possible protect bearings from unequal pressure distribution, from abrupt changes in the direction of these pressures, and from an undue rise in temperature.

The pressure distribution, which in most cases is more or less imperfect, depends on the design of the crankshaft, and will be discussed more in particular later. The character of pressures can be determined by means of diagrams. From these diagrams we may derive the mean bearing pressure, which, when multiplied by the circumferential velocity of the journal and the coefficient of friction, represents the work expended in friction.

The rise in temperature may be expressed as a function of the work expended in friction, if we limit ourselves to conditions under which the radiating surface of the bearing and the feed of oil are the same.

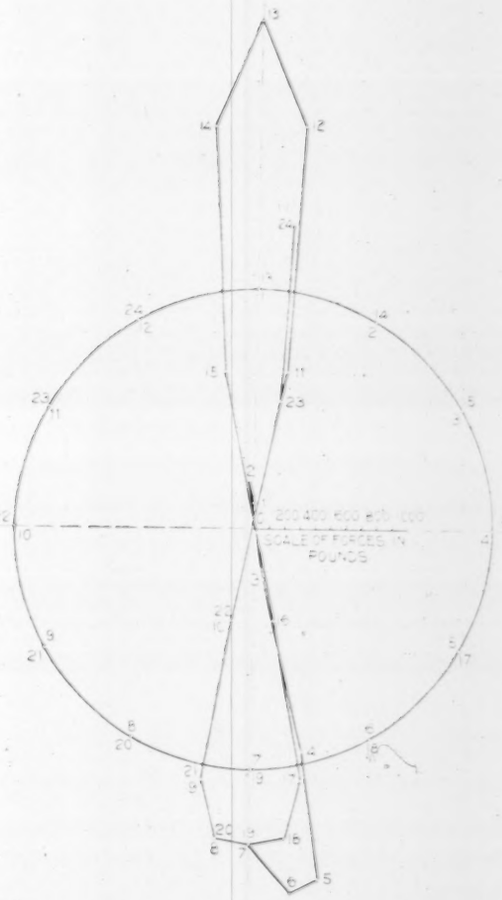

FIG. 1. CENTRIFUGAL FORCES AND COMBINED GAS AND INERTIA FORCES ACTING ON CRANKPIN OF SIX-CYLINDER ENGINE

The frictional work per square inch of bearing surface is mathematically expressed by:

$$w = \mu \frac{P}{dL} \times \frac{d\pi V}{12 \times 60} = \mu p v \qquad 1]$$

where

w = work expended in friction per sec. and per sq. in. of bearing surface
μ = coefficient of friction
P = total bearing load, lb.
p = specific bearing load, lb. per sq. in.
d = diameter of shaft, in.
L = length of bearing, in.
N = speed of shaft, rev. per min.
v = circumferential velocity of shaft, ft. per sec.

[1] Unwin, Elements of Machine Design, part 1, p. 243.

[2] Proc. Inst. M. E., 1883 and 1884.

From [1] it follows that

$$pv = \frac{PN}{229L} \qquad [2]$$

According to data gathered from well-performing and durable engines it may be stated that the value pv should not exceed 17,000 ft-lb. per sec. This value is far in excess of other similar values. Güldner states that in case of stationary gas engines the maximum limiting value of pv based on experience is about 1500 ft-lb. per sec. for bearings lined with white metal. From this it is evident that a value of 17,000 ft-lb.

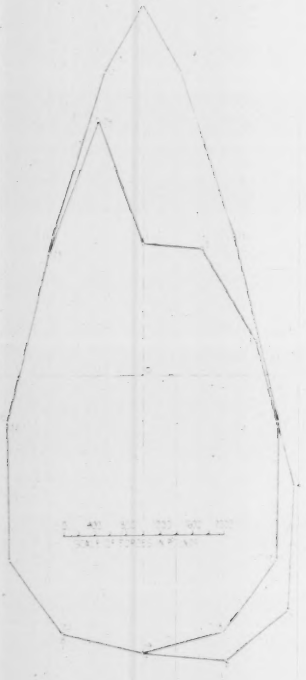

FIG. 2 COMBINED CENTRIFUGAL, GAS AND INERTIA FORCES ACTING ON CRANKPIN OF SIX-CYLINDER ENGINE

per sec. is permissible only in cases where forced lubrication is used.

In this connection it might be suggested that determination of pv values for various lubricating systems would be very desirable.

To apply this pressure-velocity criterion to the two engines under consideration it is necessary to determine the mean pressure of a complete cycle from Figs. 2 and 4. These are 2870 and 1650 lb. for the six and twelve, respectively. Assuming a crankpin diameter of $2\frac{1}{8}$ in. for either engine, we obtain, at 2700 r.p.m., a rubbing velocity of

$$V = \frac{2\frac{1}{8} \times \pi \times 2700}{60 \times 12} = 25.02 \text{ ft. per sec.}$$

With a crankpin length of 2 in. we obtain, in the case of the six,

$$pv = \frac{2870 \times 2700}{229 \times 2} = 16{,}900 \text{ ft-lb. per sec.}$$

With a crankpin length of 1 5/32 in. we obtain, in the case of the twelve,

$$pv = \frac{1650 \times 2700}{229 \times 1\ 5/32} = 16{,}825 \text{ ft-lb. per sec.}$$

The total crankpin length of the twelve, if the connecting rods are arranged side by side, should therefore be 2 5/16 in. This is about 15 per cent more than the corresponding length of the six. With equal crankpin diameters for both engines, the crankpin lengths must be proportional to the load. In order to verify this the mean total load acting on the crankpin of a twelve has been determined from the diagram in Fig. 6. As expected, it is 3300 lb., or 15 per cent more than the total load acting on the crankpin of the six.

This and all further comparisons between the six- and twelve-cylinder engines are based on the assumption that both engines are running at the same speed. But, as has been emphasized before, it is general practice to run a twelve-cylinder engine somewhat faster than a six. If this were taken into consideration, the difference between both engines would of course be more pronounced.

Before accepting the crankpin lengths given above as representing the final values, we will ease our minds with regard to the magnitude of the specific bearing pressure. In the case of the six we have a maximum load of 4795 lb. The projected bearing area of a crankpin $2\frac{1}{8}$ in. in diameter and 2 in. long is $4\frac{1}{4}$ sq. in. This gives a specific pressure of 1125 lb.

In the case of the twelve we have a maximum load for each cylinder (taken from Fig. 4) of 2660 lb. and a projected bearing area of $2\frac{1}{8} \times 1\ 5\ 32 = 2.46$ sq. in. This necessitates a

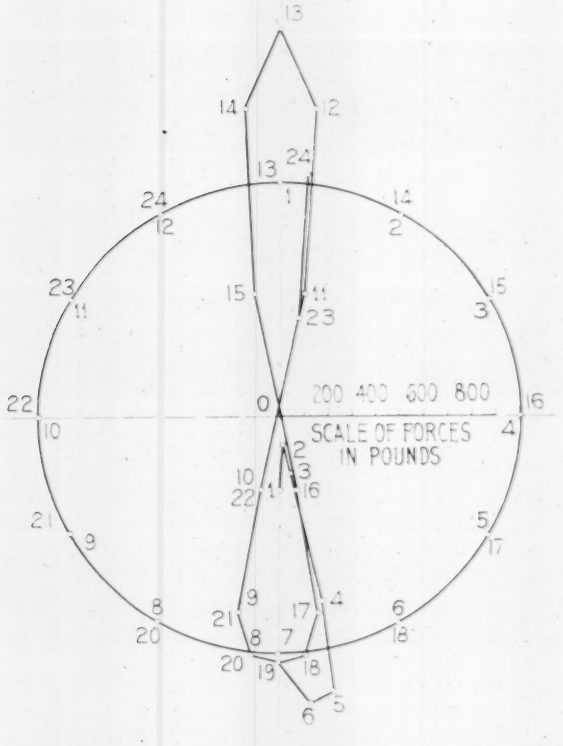

FIG. 3 CENTRIFUGAL FORCES AND COMBINED GAS AND INERTIA FORCES DUE TO ONE CYLINDER ACTING ON CRANKPIN OF TWELVE-CYLINDER ENGINE

specific bearing pressure of 1080 lb. The difference between both values is only 4.1 per cent, and both are of such magnitude as to be just about permissible. If the engines are to be used for automobile propulsion, then it may be borne in mind that maximum speed is generally not maintained for any great length of time. The loads above given would represent, then, the exception and not the rule.

Automobile engines, however, are frequently subject to hard usage when long hills are climbed on high gear. Under such conditions the explosive pressures alone determine the loads on the bearings, because the speed of the engine is generally

so low that the inertia and centrifugal forces are negligible. Assuming an explosion pressure of 380 lb. per sq. in. for both engines, we obtain total explosive loads of 4200 and 2690 lb. for the six and the twelve, respectively. In the first case we obtain a specific crankpin pressure of $4200 \div 4.25 = 990$ lb., while in the second we obtain $2690 \div 2.46 = 1095$ lb. The difference between both engines is here 10.6 per cent in favor of the six. The loads of the two engines due to explosive pressure alone are somewhat smaller than those obtained before at high engine speed.

All forces acting on the crankpin necessitate reactions on the main bearings. The total load on the main bearings also includes the centrifugal forces due to the crankpin and the adjacent crank cheeks. Theoretically, and now even practically, it is a simple matter to attach weights to the crankshaft that will relieve the main bearings on the centrifugal forces. Whether it is an advantage to do so will be presently investigated by means of diagrams.

The forces to be dealt with at first are those relating to the six-cylinder engine resolved into components in a manner as determined for a crankshaft of the seven-bearing type.

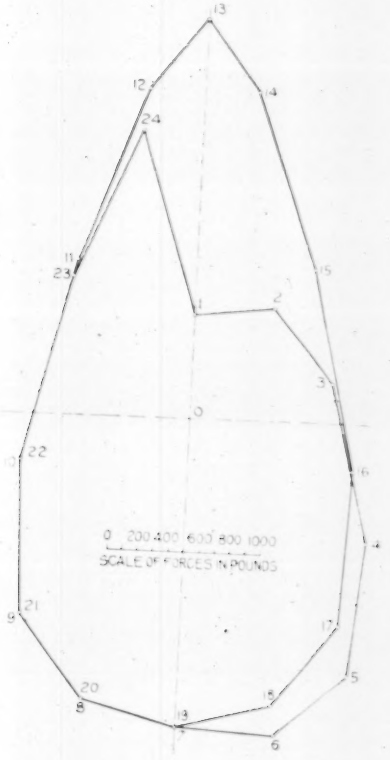

FIG. 4. COMBINED CENTRIFUGAL, GAS AND INERTIA FORCES DUE TO ONE CYLINDER ACTING ON CRANKPIN OF TWELVE-CYLINDER ENGINE

We are now concerned with two groups of diagrams:

a Main-bearing load for a crankshaft without balance weights: Fig. 7, loads on main bearings I and VII (counting from front of engine); Fig. 8, loads on II, III, V and VI; and Fig. 9, load on IV.

b Main-bearing load for a crankshaft with balance weights: Fig. 10, loads on main bearings I and VII; Fig. 11, loads on II, III, V and VI; and Fig. 12, load on IV.

It is plainly evident from the scale of the diagrams that the balance weights act to reduce considerably the loads on the bearings, but, as already stated, magnitude is not the last word to be said about loads. Sudden fluctuations in the direction of the load are equally, if not more, detrimental to a bearing than the mere magnitude of the loads. Quick changes in the direction of a force acting on a mass are always accompanied by inertia effects. We must expect, therefore, that the journals carrying loads as shown in Figs. 10 to 12 will develop an undesired reciprocating or rocking action. Figs. 7 to 9, however, represent comparatively steady loads. The journals carrying these loads will creep around on the bearing surface, an action in principle like that involved when a planetary gear rolls within an internal gear. This facilitates lubrication, because the lubricant, while adhering to the metal surfaces, is continually wedged in between the two bounding

FIG. 5. CENTRIFUGAL FORCES AND COMBINED GAS AND INERTIA FORCES DUE TO TWO CYLINDERS ACTING ON CRANKPIN OF TWELVE-CYLINDER ENGINE

surfaces. From this it is seen that beyond pounds of load per bearing there is, so far, nothing to say in favor of balance weights.

The length of the bearings necessary to carry the respective loads safely can be determined by the formula $pv = 17{,}000$ ft-lb. per sec. With a main-bearing diameter of $2\frac{1}{8}$ in. we obtain for 2700 r.p.m. of the engine a circumferential velocity of $v = 25.02$ ft. per sec. The mean loads on the bearings, as obtained from the diagrams, are given in Table 2, together with the necessary bearing lengths, the values of pv and the specific bearing pressures.

In the case of bearings I and VII a liberal amount should be added to the length of the bearing to take care of the loads due to the timing gears and the flywheel, and at least $\frac{1}{4}$ in. should be added to every bearing to allow for fillets. But in spite of this we find that the bearing lengths for the balanced type are entirely too short to hold the requisite oil pressure. If they are lengthened so that they are in conformity with *this* practical consideration we will obtain bearings for a crankshaft *with* balance weights about as long as those for a crankshaft *without* balance weights.

Apart from these analytical considerations it has now become an established fact that the smooth running, life and power of a well-designed engine with a seven-bearing shaft cannot be improved by the addition of balance weights. This is true in spite of the fact that any shaft with balance weights will perform much better on any balancing machine than will its prototype without balance weights. This paradoxical result is easily explained if we bear in mind that a shaft when running in a balancing machine is not subject to the sudden im-

pulses which are a necessary evil inherent to the reciprocating engine. It seems that the best method to make these impulses harmless is to smooth them out by means of the centrifugal forces, which, as we know, are available "free of charge."

It remains now to determine the loads on the main bearings for the twelve-cylinder engine in a manner similar to that which was adhered to in the case of the six. However, since there is not the slightest difference in the procedure, it is permissible to draw conclusions from former results. We must therefore reconcile ourselves with the fact that in all cases the

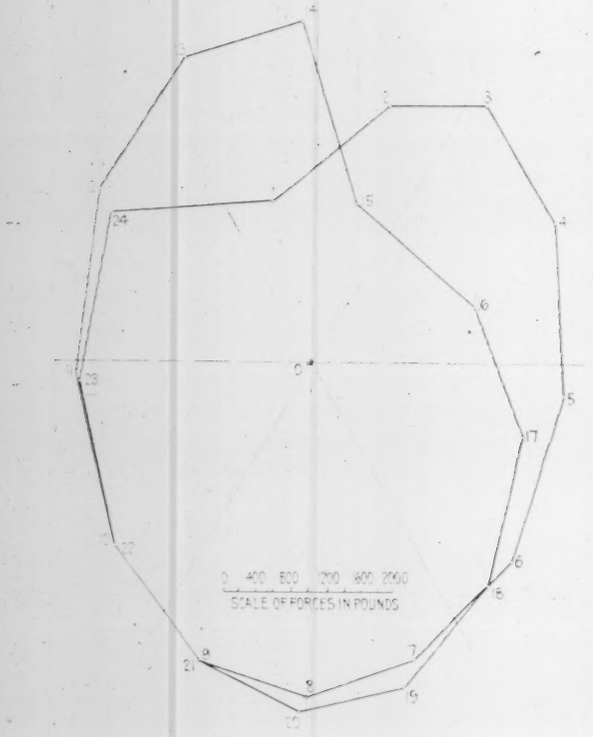

FIG. 6 COMBINED CENTRIFUGAL, GAS AND INERTIA FORCES DUE TO TWO CYLINDERS ACTING ON CRANKPIN OF TWELVE-CYLINDER ENGINE

mean pressure of a complete cycle will be about 15 per cent in excess of the corresponding pressures represented in Figs. 7 to 12. This conclusion is based on the results derived from the force diagrams shown in Figs. 2, 4 and 6. These diagrams show that the mean pressure on the crankpin of a twelve-cylinder engine is 15 per cent larger than that on the crankpin of a six.

In the case of a twelve with two connecting rods mounted side by side on one crankpin the distribution of load over the whole length of the crankpin is not uniform, because the loads on the two connecting rods do not at every instant act with equal intensity. The point of application of the resulting loads given in Fig. 6 is therefore not in the middle of the crankpin, as is the case with the loads given in Fig. 2. The two main bearings adjacent to the crankpin (seven-bearing crankshaft) will not receive at every instant exactly half the loads given in Fig. 6, but alternately the one will receive somewhat more and the other somewhat less than half of the total for well-known mechanical reasons.

This rough-and-ready analysis, however, permits the conclusion that the main bearings of a twelve-cylinder engine should be designed to give at least 15 per cent more bearing surface than main bearings which have proved successful for a six-cylinder engine of equal capacity.

In the preceding discussion we have been dealing with various dimensions for crankpins and main bearings. These

TABLE 2 DATA FOR BALANCED AND UNBALANCED CRANKSHAFTS

Bearing number	Type of crankshaft	Mean load	Theoretical bearing length	Value of pc	Mean specific bearing pressure
I, VII	Balanced	774	⅞	16,260	648
	Unbalanced	2180	1⅜	16,425	677
II, III, V, VI	Balanced	889	⅞	15,800	633
	Unbalanced	2190	1⅜	16,500	660
IV	Balanced	1529	1⅜	16,725	670
	Unbalanced	4350	3	17,040	682

dimensions were chosen according to the dictation of sound engineering. While this method is satisfactory, it is well to verify the results obtained, perhaps in the following manner. Both engines so far spoken about will develop probably a

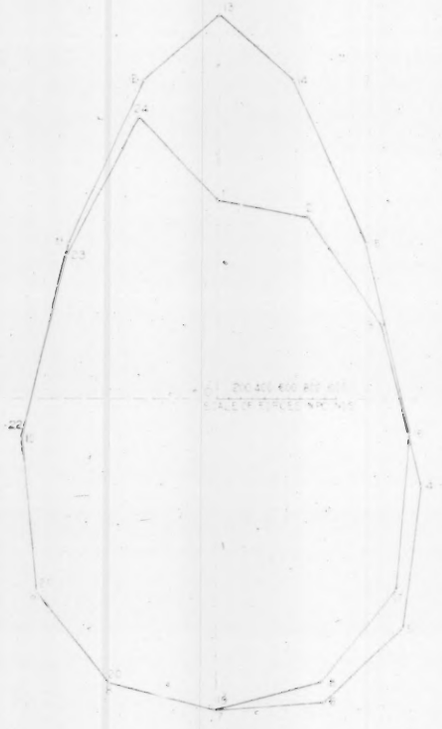

FIG. 7 LOADS ON MAIN BEARINGS NOS. I AND VII OF CRANKSHAFT WITHOUT BALANCE WEIGHTS

maximum torque of about 3000 in-lb. This would correspond to about 48 hp. at 1000 r.p.m. However, the torque on the crankshaft is subject to considerable fluctuation, depending on the number of impulses. This fluctuation, which, of course, has some bearing on the operating smoothness of an engine, was made the subject of many investigations in the early days of the six, and again at the advent of the eight and the twelve. Such investigations have revealed that the multi-cylinder engine, six, eight, twelve, etc., certainly deserves great credit for its smooth torque.

Owing to the small number of impulses, the torque on the crankpin of a six-cylinder engine may at intervals be two and

a half times as large as the torque indicated on the dynamometer. In considering the strength of the crankshaft we must therefore deal with a torque of, say, 7500 in-lb. With a crank radius of $3^1/_8$ in. this torque results in a tangential force of 2400 lb., acting through the crank cheek on the crankpin as indicated in Fig. 13.

If we at first assume the crank cheeks as being infinitely strong, we can consider the crankpin as a cantilever. With a crankpin length of 2 in., plus half the width of the cheek, the total length of the cantilever will be about $2^1/_2$ in.. The bending moment is, consequently, $2400 \times 2^1/_2 = 6000$ in-lb. The moment of resistance to bending of a $2^1/_8$-in. diameter cylinder with a 1-in. hole is 0.896 in.^{3} With an elastic limit of 110,000 lb. per sq. in. (chrome-nickel steel) we obtain from these data 16.4 as the factor of safety. Crankpins are further subject to some shearing and bending due to the load acting directly on them, but in the above calculation this has not been taken into consideration. If we allow for these extra stresses we may obtain a final factor of safety of 12, which is not too much for so important a part as a crankshaft.

After this we may now assume the crankpin to be infinitely strong. From this point of view we must expect the crank

Fig. 8 Loads on Main Bearings II, III, V and VI of Crankshaft Without Balance Weights

cheeks to deflect in a manner as shown in Fig. 13. The twisting moment to be resisted by the cheeks evidently is $2400 \times 3 = 7200$ in-lb. The moment of resistance to torsion of a rectangular section is $2b^2h/9$. The permissible fiber stress in case of twist is about 75 per cent of that permissible for bending. Taking this into consideration, and maintaing a factor of safety of 12, gives the following equation:

$$7200 = 2 \times \frac{0.75 \times 110{,}000}{12} \times \frac{2}{9} b^2 h$$

From this, taking $h = 2^3/_4$ in., we obtain the thickness of the cheek b as 0.925 in.: or, to give an even figure, 15/16 in. This small special allowance is desirable because the crank cheeks, like the crankpins, are subject to compound stresses.

In this connection it may be remarked that, as a rule, the crank cheeks are found to be the weakest parts. Fig. 13 and the calculations explain why so many shafts break along the lines marked *A B C*.

In the case of the twelve-cylinder engine the maximum torque on the crankpin will be only about 50 per cent more than that indicated on the dynamometer. We shall therefore have to deal with a torque of about 4500 in-lb. With a crank radius of $2^1/_2$ in. we derive from this torque a tangential force of 1800 lb. acting through the crank cheeks on the crankpin. With a crankpin length of 2 5 16 in., plus half the width of the cheek, we have a total length of $2^3/_4$ in. The bending

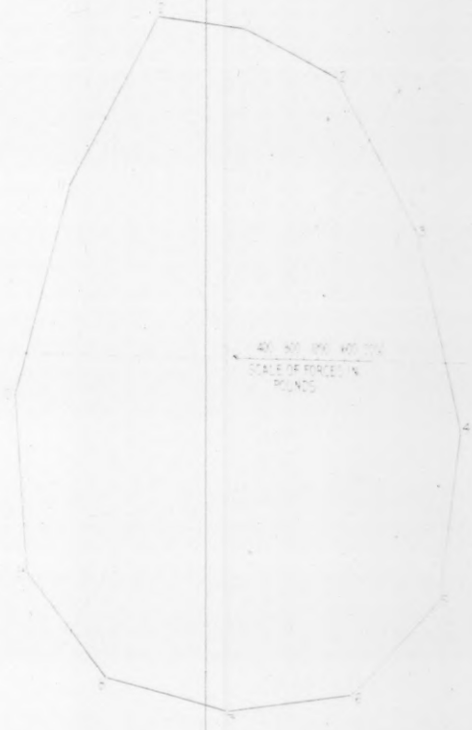

Fig. 9 Loads on Main Bearings IV of Crankshaft Without Balance Weights

moment on the crankpin is therefore $1800 \times 2^3/_4 = 4950$ in-lb. The factor of safety derived from this is 20. The twisting moment in the crank cheeks is $1800 \times 3\ 3\ 16 = 5740$ in-lb.

The thickness of the cheeks with a factor of safety of 12 we derive as before from the equation:

$$5740 = 2 \times \frac{0.75 \times 110{,}000}{12} \times \frac{2}{9} b^2 h$$

From this we obtain a cheek thickness of 0.83 in., or, say, $^7/_8$ in.

In order to compare a three- and seven-bearing shaft it must first of all be observed that the distance between the centers of the two main bearings is about two and a half times as much in the former shaft as in the latter. The transverse deflection of a straight shaft increases as the cube of the distance between the supports. It is evident, therefore, that if other conditions are the same, a three-bearing shaft will deflect up to $(2^1/_2)^3$: that is, nearly sixteen times as much as a seven-bearing shaft.

It is hardly necessary to point out that excessive deflections are certainly not conducive to the operating smoothness of an engine. Not only that, but even the durability of the bearings is impaired, because a deflected shaft will not permit uniform

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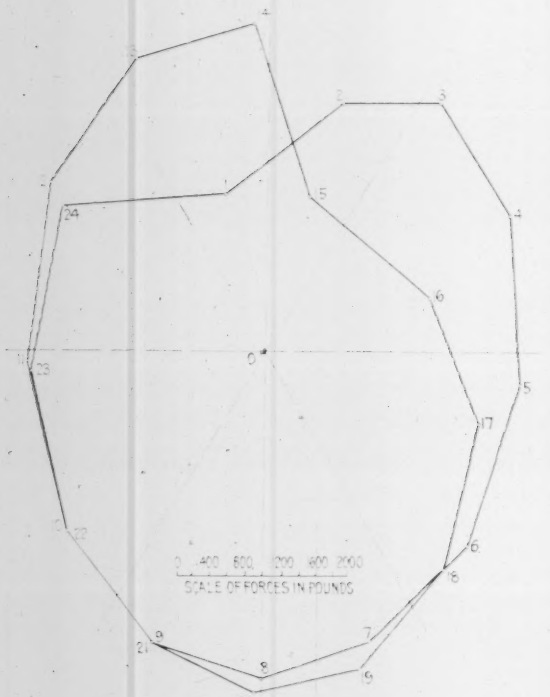

FIG. 6 COMBINED CENTRIFUGAL, GAS AND INERTIA FORCES DUE TO TWO CYLINDERS ACTING ON CRANKPIN OF TWELVE-CYLINDER ENGINE

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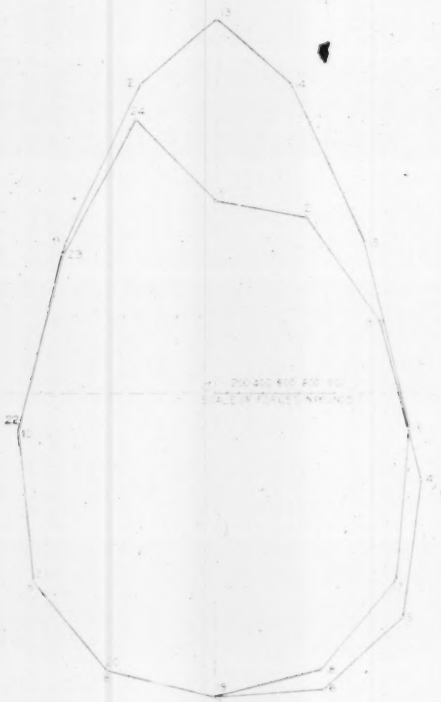
Bearing number	Type of crankshaft	Mean load	Theoretical bearing length	Value of pc	Mean specific bearing pressure
I, VII	Balanced	774	$\frac{7}{8}$	16,200	648
	Unbalanced	2180	$1\frac{3}{8}$	16,425	657
II, III, V, VI	Balanced	839	$\frac{7}{8}$	15,800	631
	Unbalanced	2100	$1\frac{3}{8}$	16,500	660
IV	Balanced	1520	$1\frac{3}{8}$	16,725	670
	Unbalanced	4350	3	17,030	682

dimensions were chosen according to the dictation of sound engineering. While this method is satisfactory, it is well to verify the results obtained, perhaps in the following manner. Both engines so far spoken about will develop probably a



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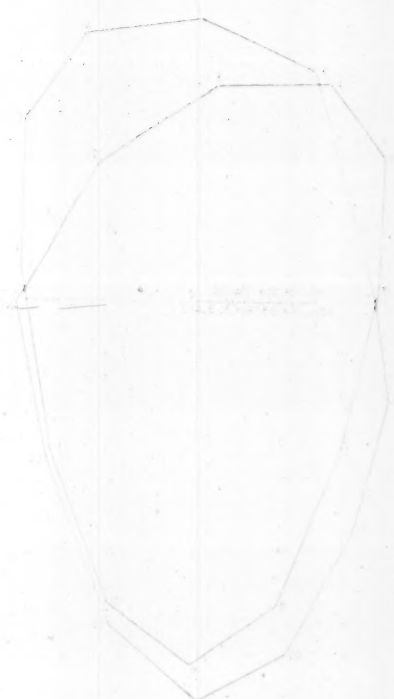

FIG. 8. LOADS ON MAIN BEARINGS II, III, V AND VI OF CRANKSHAFT WITHOUT BALANCE WEIGHTS

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From this, taking $h = 2\frac{3}{4}$ in., we obtain the thickness of the cheek b as 0.925 in.; or, to give an even figure, 15/16 in. This small special allowance is desirable because the crank cheeks, like the crankpins, are subject to compound stresses.

In this connection it may be remarked that, as a rule, the crank cheeks are found to be the weakest parts. Fig. 13 and the calculations explain why so many shafts break along the lines marked *A B C*.

In the case of the twelve-cylinder engine the maximum torque on the crankpin will be only about 50 per cent more than that indicated on the dynamometer. We shall therefore have to deal with a torque of about 4500 in-lb. With a crank radius of 2½ in. we derive from this torque a tangential force of 1800 lb. acting through the crank cheeks on the crankpin. With a crankpin length of 2 5/16 in., plus half the width of the cheek, we have a total length of 2¾ in. The bending

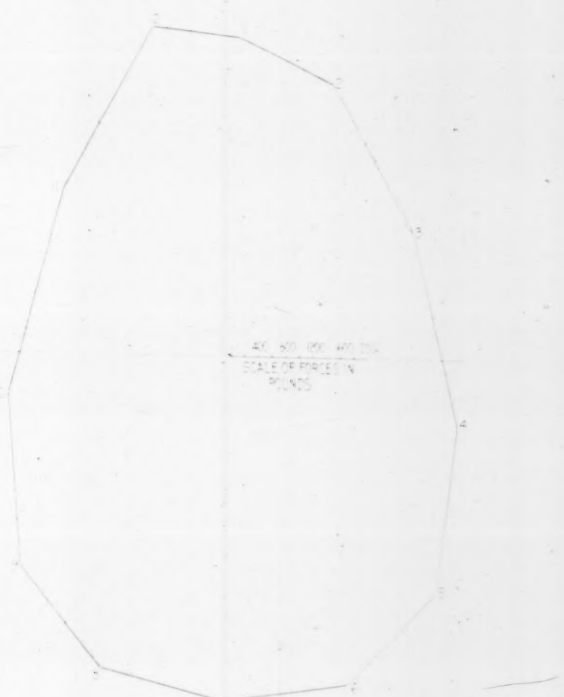

FIG. 9. LOADS ON MAIN BEARINGS IV OF CRANKSHAFT WITHOUT BALANCE WEIGHTS

moment on the crankpin is therefore $1800 \times 2\frac{3}{4} = 4950$ in-lb. The factor of safety derived from this is 20. The twisting moment in the crank cheeks is $1800 \times 3\ 3\ 16 = 5740$ in-lb.

The thickness of the cheeks with a factor of safety of 12 we derive as before from the equation:

$$5740 = 2 \times \frac{0.75 \times 110{,}000}{12} \times \frac{2}{9} b^2 h$$

From this we obtain a cheek thickness of 0.83 in., or, say, ⅞ in.

In order to compare a three- and seven-bearing shaft it must first of all be observed that the distance between the centers of the two main bearings is about two and a half times as much in the former shaft as in the latter. The transverse deflection of a straight shaft increases as the cube of the distance between the supports. It is evident, therefore, that if other conditions are the same, a three-bearing shaft will deflect up to $(2\frac{1}{2})^3$: that is, nearly sixteen times as much as a seven-bearing shaft.

It is hardly necessary to point out that excessive deflections are certainly not conducive to the operating smoothness of an engine. Not only that, but even the durability of the bearings is impaired, because a deflected shaft will not permit uniform

pressure distribution in the bearing. Any eccentricity of the loading relatively to the middle of the bearing will create a tendency to drive out the oil at one end. This is the reason why bearings that swivel so as to accommodate themselves to any inclination of the journal on account of bending of the shaft are found to be of great advantage. However, as such bearings cannot be applied very well to crankshafts, it is advisable to design crankshafts so that their deflections approach a minimum.

The deflection of a shaft varies inversely as the moment of inertia of its weakest section. In order, then, to hold a three-bearing shaft within the same limit of transverse deflection as may be obtained with a seven-bearing shaft the crankpin diameters of both shafts must be proportioned in the relation of $\sqrt[4]{16}$ to 1, which is as 2 to 1. This necessitates a crankpin diameter of $4\frac{1}{4}$ in. for a three-bearing shaft designed to conform to our premises. For so small an engine as here under consideration this diameter is, of course, prohibitive. At the same time, it is almost prohibitive to use a seven-bearing shaft for a twelve-cylinder automobile engine on account of the excessive length. The only alternative left for the designer of such engines is to sacrifice rigidity.

The torsional deflection of a crankshaft is directly proportional to the torque moment. In a seven-bearing crankshaft a torque moment of the magnitude $M = T \times r$ occurs in the main bearings only. This torque is determined by the tangential force T acting on the crankpin and by the crank radius r, which is one-half the stroke of the engine.

In a three-bearing crankshaft a similar but more intense torque occurs, not only in the main bearings but also in the crankpin, as illustrated in Fig. 14. The momentum of the torque in this case is determined by T and by the shortest distance between T and the center of the twisted crankpin, which is denoted by R. From Fig. 15 we find that $R = r + r \sin 30^\circ$ or $R = 1.5\ r$. Consequently, in this case, $M = T \times 1.5\ r$. This permits us to draw the conclusion that the torque moments or torsional deflections of a three- and a seven-bearing crankshaft stand to each other in the relation of 1.5 to 1. It must further be mentioned that the twist in a crankpin is a more serious matter than the twist in the main bearings. We must consider that the only way to reduce the vibrations set up by a twist in a crankpin is by an increase in its diameter. The deflections in the main bearings may, however, be minimized by vibration dampers.

The same line of reasoning which we have established in connection with the three-bearing shaft must be followed in investigating a four-bearing, six-throw shaft. The distance between two bearings is about 1.75 times as great as in the case of a seven-bearing shaft, and consequently the transverse deflection is about five times larger. With regard to the torque in the crankpins, the same figures as before established apply, except that in this case a smaller number of crankpins are subject to twist.

As excessive transverse deflections must be detrimental to the bearings as well as to the operating smoothness of the engine, it is quite reasonable to expect that balance weights will be an advantage for the latter two types of crankshafts, which are inherently weak. Seven-bearing crankshafts, when well designed, are inherently strong enough so that they cannot be improved through the addition of balance weights. We can predict, therefore, that the use of balance weights will be limited to shafts with a smaller number of bearings than would be desirable from the viewpoint of strength. Balance weights

FIG. 10

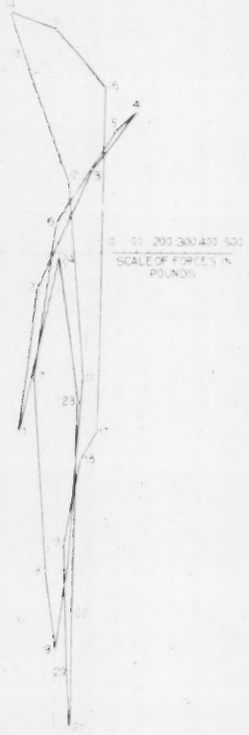

FIG. 11

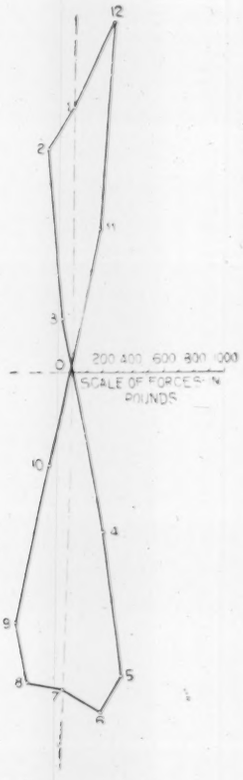

FIG. 12

FIG. 10 LOADS OF MAIN BEARINGS I AND VII. FIG. 11 LOADS ON II, III, V AND VI OF A CRANKSHAFT WITH BALANCE WEIGHTS
FIG. 12 LOADS ON IV

are like the flywheel, the symbol of some imperfection. If we compare shafts of equal strength we will further find that the weight of a three- or four-bearing, six-throw crankshaft that is properly balanced will by no means be less than that of a seven-bearing shaft.

The total piston displacements of different engines designed with a constant stroke-bore ratio are proportional to the cube of the cylinder bore. For instance, if the bore of an engine is b, and its stroke is $1.667b$, the piston displacement of this engine per cylinder is $(b^2\pi \div 4) \times 1.667b = 1.309b^3$.

The explosive impulses of different engines are proportional

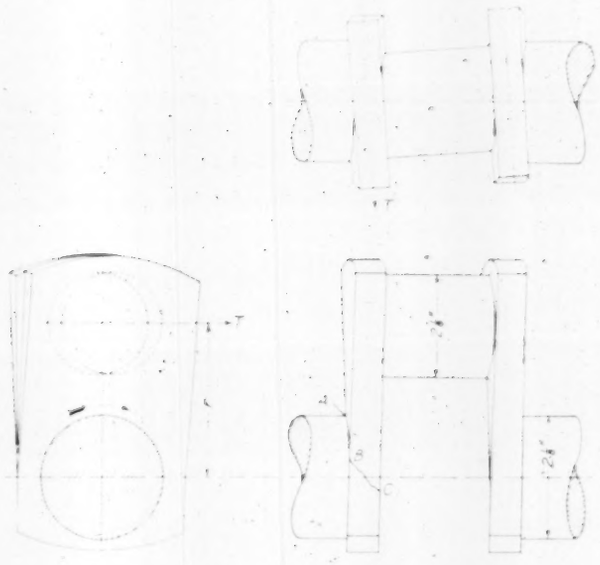

FIG. 13 PART OF CRANKSHAFT ILLUSTRATING DEFLECTION OF CRANK-CHEEKS

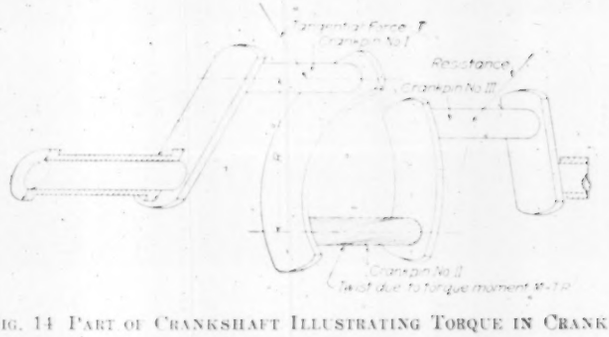

FIG. 14 PART OF CRANKSHAFT ILLUSTRATING TORQUE IN CRANK-PIN IN CASE OF THREE- AND FOUR-BEARING SIX-THROW CRANKSHAFTS

to the square of the cylinder bore, providing that the same compression is used throughout. Denoting the bore of a six-cylinder engine with b_6 and that of a twelve-cylinder engine with b_{12}, we find for two engines of equal total piston displacement the following relation:

$$6 \times 1.309 \times b_6^3 = 12 \times 1.309 \times b_{12}^3$$

From this it follows that

$$b_6 = \sqrt[3]{2} \times b_{12} \qquad [3]$$

The explosive impulse E of an engine is proportional to the square of the cylinder bore. Between the explosive impulses of a six- and twelve-cylinder engine the following relation therefore exists:

$$\frac{E_6}{E_{12}} = \frac{b_6^2}{b_{12}^2}$$

When substituting for b_6 the value given in [3], we obtain

$$\frac{E_6}{E_{12}} = \frac{(\sqrt[3]{2})^2 \times b_{12}^2}{b_{12}^2} = \frac{(\sqrt[3]{2})^2}{1}$$

In practice we invariably find that the small-bore engine is working under somewhat higher compression. This results in a higher explosive force per unit of piston area. To give an example, we may assume, for the two types of engines to be compared, that the large-bore, six-cylinder engine may work with a compression pressure of 85 lb. per sq. in., and the small-bore twelve-cylinder engine with one of 90 lb. per sq. in. Substituting this in the above given relation, we obtain

$$\frac{E_6}{E_{12}} = \frac{85}{90} \times \frac{(\sqrt[3]{2})^2}{1} = 1.5 \text{ to } 1$$

From this we learn that for a certain standard of engineering the explosive impulse of a six-cylinder engine is about 1.5 times as large as that of a twelve-cylinder engine of equal total piston displacement.

In conclusion, a few words may be said about lubrication, although this can be considered a problem all by itself. To

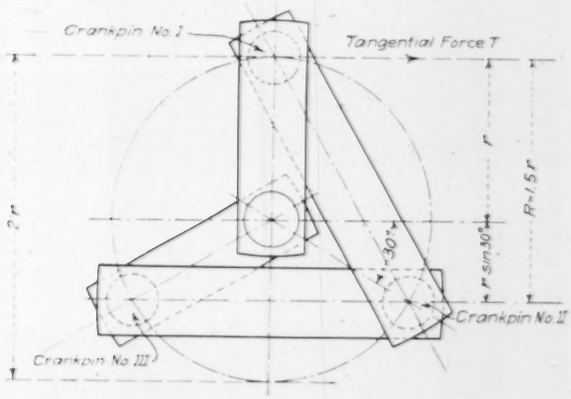

FIG. 15 PART OF CRANKSHAFT SHOWING MAXIMUM LEVERAGE IN CASE OF THREE- AND FOUR-BEARING SIX-THROW CRANKSHAFTS

obtain absolutely satisfactory conditions, the oil delivery to the bearings must be in direct proportion to the work converted into heat by the bearings. We should lay out a series of diagrams, as previously discussed, for different engine speeds and for different power outputs. The values of pv obtained from the various diagrams would give us a clear picture of how the oil delivery should be regulated. Scientific oiling would eliminate scraper rings, and thus permit lighter pistons. It would also eliminate sooted spark plugs, carbonization, preignition, and would permit higher compression.

In the production of aircraft engines, as in all other departments of engineering, it is necessary to effect a reasonable compromise between two conflicting ideals. Standardization leads to a greatly augmented rate of production, but simultaneously makes it correspondingly more difficult to effect the improvements which steadily increasing experience may show to be possible. Cases could readily be cited in which attempts at standardization of machinery on the basis of inadequate experience have proved well nigh ruinous, and the departments concerned were undoubtedly wise in the first instance in leaving open a wide field for invention and improvement. The result of this has been that our best engines are claimed to be two years ahead of the best produced by the enemy, which in true Teutonic fashion have been developed along humdrum lines.—*Engineering*, January 25, 1918.

OFFENSIVE AGAINST THE SUBMARINE

With Annotations to the Suggestions to Inventors Made by the Naval Consulting Board of the United States Regarding the Submarine and Kindred Problems

By JOSEPH A. STEINMETZ, PHILADELPHIA, PA.

Member of the Society

IN discussing the tremendous creative zeal of the nation's inventors, especially in suggesting methods of solving the submarine problem, the Honorable Secretary of the Navy recently mentioned that 40,000 separate suggestions, plans, or models of offensive and defensive devices had been submitted to the Naval Consulting Board since the United States entered the war against Germany.

"The idea that the submarine will be overcome by a miraculous invention is not now seriously considered," the Secretary said. "The more intimate knowledge the civilian obtains on this subject, the more convinced he is that the submarine can be conquered by persistently hunting it down by the weapon of which it is most afraid. This is the armed service boat, equipped with all the latest scientific devices and typified in the modern torpedo-boat destroyer. Foreign naval authorities have frankly stated their admiration of the degree of perfection of American designs.

"In regard to the protection of ships against torpedo attack, the undeniable evidence of recent months of submarine activity has demonstrated that the immunity of a vessel depends very largely on its speed and maneuvering ability. There is a possibility that some artificial means of protecting cargo-carrying vessels may be found practicable. In no other field have so many suggestions or so many duplicate inventions been presented to the Board."

The Secretary said that the thought on submarine defense may be subdivided into three groups:

1 Any methods to accomplish the destruction of submarines, involving detection and destruction after detection

2 Means of avoiding submarine attack, involving instructions for merchant vessels, proper handling of vessels, camouflage, smoke screens, and other confidential information known to American naval authorities

3 Protection of ships against torpedo hits.

All the suggestions submitted received careful consideration by the Board, and much valuable aid has been given to various branches of the war service. Many inventions of real merit have been submitted; on the other hand, many proposals have been found to be impractical, largely due to the failure of inventors to inform themselves properly of principles.

To destroy a submarine we must first find it, and therefore the problem of catching, as mentioned, is in its proper order of importance. The difficulty is that the submarine has the greater advantage of lower visibility, approximating invisibility. Before it can be located, it gets home a surprise torpedo. Ninety per cent of the damage and loss comes from that first torpedo, and the necessity of forehand knowledge of the submarine's location, in relation to the approaching ship, bears an equal percentage of importance to the equation.

In certain conditions of sea and weather it is practically impossible, by visual observation, to detect a periscope. Various listening devices are being developed with most encouraging results.

To locate the submarine does not solve the problem of its extinction, and the Secretary is right in recognizing a solution of the menace by direct-gunfire attack. The more guns we mount on our commerce ships and the greater the increase of our swift-destroyer class, the more certainly have we met the submarine. We must blow him out of the water and hunt him from base to base by direct-gunfire attack.

Of late there has been perfected a means of deep-water attack against submerged submarines by the use of the selective-depth bomb. This device, variously charged with from 50 to 500 lb. of TNT or other high explosive, is so arranged that it will detonate at a predetermined depth, estimated to reach the level of the submarine that is lurking below the surface. These depth charges are launched from fast surface craft whose speed carries them away from the eruptive danger following the explosion. The under-water shock is sufficient to break in the hull plating of a submarine in any direction and up to a distance equal to about three times the vertical depth at which the charge explodes.

A well-known type of depth bomb provides a hollow float connected to a thin cable or cord wound around the outside of the explosive container, the depth of detonation being determined by the length of the unwinding cord that pulls the detonator when the mine reaches its selected depth.[1]

Reference is here suggested to the topographical map and contour of the bed of the North Sea, which, contrary to popular supposition, is a comparatively shallow body of water, except for three guts or submarine lanes and the greater deep channel along the Norwegian coast.

The Dogger Bank ridge is but 50 ft. deep, and the average bottom of the North Sea lanes about 200 to 300 ft.; while the deep strip, or main lane on Norway's edge, is 900 ft. deep.

An attack by continuous barrage discharge of depth mines from numerous patrols covering each known submarine lane would check the freedom of these passages with justifiable chance of destroying the enemy U-boats.

The Naval Consulting Board, known so favorably to us all, has worked indefatigably in the consideration of the vast number of suggestions that have been offered. As a guide to help solve the submarine menace the Board issued a bulletin[2] entitled The Submarine and Kindred Problems. As this information is official and helpful to a clear understanding of submarine warfare, offensive and defensive, it would be proper to quote fully from the bulletin.

Protection Against Submarine Attack

This subject, which is occupying the public mind as is no other, divides itself into a number of problems, the most important being the following:

a Means of discovering the approach of a hostile submarine and locating it so as to permit of prompt action for combating its attack

[1] U. S. Patent Application Serial No. 161,874.

[2] Bulletin No. 1, July 14, 1917. Copies free by addressing Navy Department.

Abstract of paper presented before the Philadelphia Section of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, December 11, 1917.

b Protection of cargo-carrying ships by nets, guards and screens

c Protection through decreasing the visibility of vessels

d Methods of destroying or hunting a hostile submarine.

To these may be added:

e Mines, their use and control

f Torpedoes, use and counter-defense.

Submarines, to operate most effectively, must approach within close range of the vessel which is intended to be torpedoed. The installation of offensive weapons on the merchant marine has increased the necessity for the utmost care being exercised by the submarine commander in remaining unseen by the officers on the vessel to be attacked.

Reports from abroad indicate that in many cases submarines must have remained along certain lanes of travel for periods extending into weeks of waiting with the expectation of torpedoing certain vessels. Under certain favorable conditions, where the waters are less than 200 ft. in depth, the safe limit of descent, a submarine might lie at rest on the bottom, and, if equipped with sensitive listening devices, attempt to detect the approach of a vessel. As soon as this evidence was secured the submarine might come to the surface for a quick observation by means of the periscope and in this manner obtain the proper aim which would be required to register an effective hit.

In case the water is more than 200 ft. in depth, a submarine must be kept in motion to obtain steerage way in order to hold its proper depth of submergence. This speed may not exceed four or five miles per hour, but to remain submerged, and at the same time unobserved, the water must be at least 60 ft. deep.

The latest type of submarine which is being used abroad has a surface speed of at least 17 knots and a submerged speed of probably less than 10 knots. The superior gunfire from the merchantman which has been properly equipped would make it necessary for the submarine commander to obtain his observations, such as would permit accurate aiming of the torpedo, during the very brief interval of time required to come to the surface for observation through the periscope and to again submerge.

If running near the surface, the periscope might be raised, a quick observation taken, and lowered again within 30 seconds. If, however, the submarine is on the surface and hatches uncovered, from one to four minutes will be required to completely submerge, depending upon circumstances.

A submarine of recent type probably has a total radius of action of as much as 8000 miles when traveling at a moderate cruising speed of from 10 to 11 knots, and may remain away from its base for as much as one month, without requiring either fuel or other supplies during this period.

This type of submarine may have as many as 3 periscopes, 2 conning towers, and 2 rapid-fire guns attached to the upper portion of its hull. The vessel is steered by very efficient gyroscopic compasses, which are unaffected by extraneous magnetic or electrical influences.

The *U-53* on her espionage visit to Newport Naval Station and her subsequent torpedoing of a half-dozen friendly and neutral ships within sight of our shore, is a concrete instance of what can be done as to radius of action and what may be again attempted in greater force.

A recent estimate of an allied naval officer determines that the enemy submarines are at surface over 95 per cent of their time when cruising, thus giving opportunity of accidental sinking by night ramming by surface craft as well as for direct surprise attack during fog intervals.

The fact that submarines are submerged so little of the time has developed a simple yet efficient strategy to determine their location. The Allies have used their submarines as feed lures for seagulls, which hover over the hulls tempted by their food, and follow untiringly in the wake of the submerged craft. The gulls, not distinguishing between friend and foe, follow the German submarines patiently, expecting to be fed, and quite innocently declare the location of the enemy boats to the allied patrols.

A general understanding of the capabilities of the modern submarine for offensive operations will make it easier to appreciate the importance of the three problems which follow:

(a) *Means for Discovery*

The Aeroplane. When the condition of sea and air are favorable, a submarine is readily discernible from an aeroplane flying at a sufficient height, even though the submarine be submerged to a considerable depth.

While aeroplanes have thus been used successfully in the English Channel, they are unable to fly far out to sea where the submarines are now most active. Mother ships for carrying and launching aeroplanes might be used in this connection, but there are only a small number of such ships in operation and the construction of others under present conditions is necessarily a slow process.

The aeroplane promises to play a very serious and important part in sea warfare and torpedo service.

Admiral Fiske, U. S. N., retired, invented some years ago a torpedoplane which is in effect a seaplane carrying on its keel parallel a marine torpedo. The torpedoplane delivers its attack directly in line with the enemy ship. It skims close to the surface and releases the torpedo, which speeds to its target.

The Germans are reported to have used this device successfully in sinking allied surface craft in the North Sea. Private initiative and subscribed money are now reputed to be developing this method into a practical device for our own use.

A similar weapon is described in U. S. Patent No. 1,223,212, covering an aero-marine torpedo which provides for a tubular-shaped charge towed by an aeroplane. The latter, rising in flight, drags a wire towline across the victim ship and, speeding onwards, brings the torpedo into explosive contact.

Aeroplanes have been suggested for use in attacking submarines by trailing under-water deflected bombs.[1]

Location of submerged U-boats by the use of kite observation balloons towed from battleships is one of the later developments of offense. From the high elevation the observer controls an extensive sea area, which permits the discovery of the submarine, the location being announced by wireless and the destroyers and seaplanes with depth bombs called to the attack.

Various sound-recording devices, intended to locate surface vessels, submarines, and even moving torpedoes, are now being carefully tested. Water is an excellent conductor of sound, and the development and improvement of such apparatus offers a promising field for inventive endeavor to those who possess adequate scientific training and laboratory facilities.

Many devices are suggested which depend upon optical means of detection, such as special forms of telescopes and field glasses to be mounted on ships or on scouting vessels. Many special forms of searchlights and projectors have been suggested.

The fact that a moving torpedo leaves in its wake a stream of air bubbles caused by the exhaust air from its propelling engines, offers, under favorable conditions, one means for discovering the approach of a torpedo. This evidence is, however, difficult to detect in a rough sea or at night, and, furthermore, the bubbles do not reach the surface of the water until after the torpedo has traveled toward its target a distance of from 50 to 200 ft.

The warhead torpedo weighs approximately 2500 lb. and travels about 10 to 15 ft. below the surface of the sea at a speed of 25 to 40 miles. We have a record of a British coastal dirigible, while flying in company with a convoy of merchantmen, sighting the track of an oncoming torpedo and a moment later observing the crash of the explosion on the target. An enemy submarine taking advantage of the state of the sea for concealment, had with great daring dived beneath the armed escort and boldly torpedoed her victim. The weather was rough and rapidly getting worse; the dirigible picked up the torpedo wake and followed back along the dead line to its source and located the submarine as a dim green shadow stealthily submerged. The airship hovered over the cigar-shaped form vaguely outlined, released numerous depth bombs, and destroyed the submarine.

[1] U. S. Patent No. 1,218,586.

The dragging of trawls, or nets, by special guard boats, not only with the view of locating submerged submarines but also to sweep up floating and stationary mines, is frequently suggested. Under certain conditions this operation is practicable and effective.

It will be seen that each of the above methods, however useful, has its limitations, and scientists and inventors should apply themselves not only to the task of improving these, but also of finding supplementary methods and devices.

(b) Protection of Cargo-Carrying Ships by Nets or Screens

Many designs of such devices are suggested, and most of them are intended to be attached to the hull of the vessel to be protected. Many other suggestions along these lines, and differing only in some of their minor characteristics from the foregoing, have been received by the Board. Up to the present time not one of these proposals involving screens of any kind has received the approval of the Navy Department or of the merchant marine. The principal objections offered to these devices are that they are heavy, difficult to hold in position, unmanageable in a heavy sea, and that they interfere with the speed and with the ability of the vessel to maneuver. The undeniable evidence which has been accumulated during the past few months of submarine activity has demonstrated that the immunity of a vessel to submarine attack is dependent very largely on its speed and also its maneuvering ability. The percentage of vessels having speeds of 15 knots or more which have suffered from submarine attack is very small, while the losses of slow vessels, whose speed is less than that of a submerged submarine, is practically 100 per cent of those attacked. Many of the suggested devices would prevent the launching of lifeboats or rafts from the vessel to be protected. It is barely possible, however, that there may be developed some form of this general plan which will be found practicable. In no other field have so many suggestions or so many duplicate inventions been presented to the Board.

As far back as 1877 a patent was issued containing the following paragraph: "The nature of my invention consists in combining with a vessel a sectional reticulated shield or guard, suspended at a suitable distance from the hull of the ship, and partly or wholly surrounding the same, which shield extends downward a sufficient distance below the water line to arrest a floating torpedo or explode one attached to an attacking vessel."

From that time until the present day many designs have been made, tried, and discarded. It is well known that a shield of sufficient strength and proper design will stop a torpedo, explode it, and render it harmless to the hull of a vessel, if the shield is a sufficient distance away. This distance is generally conceded to be about 30 ft. However, it depends very much upon the strength of a vessel's hull and the details of design made to localize the damage.

It has been the aim of all navies to do away with any form of shield or net protection as, in action, speed and maneuvering qualities are imperative; and generally in wartime a fleet depends for a great part of its tactical value upon its ability rapidly to change its base. Modern naval construction is made to allow torpedo attack without disabling the vessel or preventing her from continuing the fight and eventually reaching her home port. It is known that in the present war battleships have been torpedoed more than once in the same fight, continuing the battle and arriving at the home port at a fair rate of speed.

One of the great shipyards in England is interested in a torpedo-defense pontoon-supported screen that has been favorably noted in the American scientific press. This device is not a part of the ship nor attached to it, but provides a floating spar-like pontoon with a full-length sheet-steel flexible apron. These screens can be towed by the slower ships when moving through mine fields or submarine zones, giving extensive broadside protection. The pontoon screens can be towed as separate units by tugs or trawlers, and the defended ship can move safely forward, protected by these flanking screens.

The author will be glad to send to anyone interested in the further development of this line of defense an illustrated booklet on Submarine Problems and Torpedo Defense.

(c) Protection Through Invisibility

The point of lookout on a submarine being close to the water, the position of a vessel at a distance can be determined only by observing its smoke, which floats high in the air. Improved smokeless combustion is therefore desirable. Relative invisibility may also be afforded by methods of painting.

A method of camouflage to suddenly create a fog cloud about a ship is made possible by an arrangement of pipes running along outside the length of the hull, parallel and near to the keel and connected up to the steam boilers. By quickly opening the control valve the steam pressure vents through small openings in the pipe and rises as a fog cloud, instantly enshrouding the ship and confusing the submarine as to aim and direction. This is one of the many patents pending, and is mentioned only to encourage our engineers and inventors to further activities.

It is possible and desirable, if ship-design prejudice could be overcome, to build a low-visibility hull by reducing or eliminating the masts and spars and laying the funnels horizontally near the deck levels, supplementing the draft by further arrangement of blowers.

In the earlier days of the war, submarines were lured into close range by screening the deck guns of merchant steamers and liners and by false-rigging destroyers to simulate helpless sailing craft, but this deceit is increasingly difficult to accomplish as the later U-boats mount powerful long-range guns.

(d) Destruction and Blinding of the Submarines

A rapid-fire gun is effective when the submarine is seen within accurate range of the gun; but the target is so small that it is difficult to hit.

The powerful effect of any submarine explosion on all neighboring bodies provides a simple means of destroying or crippling an undersea boat. Once it has been even approximately located, the setting-off of a heavy charge of high explosive, well submerged in the vicinity of the submarine, will bring about this result.

A simple type of selective depth bomb has already been described, and the news items of destruction of enemy submarines by this method of attack give encouraging indication that in this device we have a weapon that spells the doom of the U-boat.[2]

In certain areas, a quantity of heavy, black petroleum or similar substance which will float on the surface of the water has proved an effective means of clouding the optical glass in the periscope's exposed end.

This spreading of oil results, however, in a waste without commensurable result, as a recent device operated from inside the submarine permits of the perfect cleansing of the periscope's outlook glass by projecting against the oil smooch a pressure jet of gasoline or other wash.[3]

Under favorable conditions of wind and position, many vessels have saved themselves from torpedo attack by the production of a smoke screen. This may be formed either by incomplete combustion of the oil used for fuel by most naval vessels, or it may be created by burning chemicals, such as phosphorus and coal tar, or mixtures in which both of these and other materials are used.

[1] Reference is also made to U. S. Patents Nos. 1,219,879 and 1,171,153.

[2] U. S. Patent Application Serial No. 161,874.

[3] U. S. Patent No. 1,222,156.

After hiding itself from the submarine in a cloud of dense smoke, the vessel, if possessed of sufficient speed, may be able by a quick maneuver to change her position and escape before the submarine is able to discharge a torpedo.

The serious fault with this plan has been the accidental condition of windage, for it is apparent that if the wind blows from the direction of the submarine toward the ship she cannot hide quickly in her smoke screen, which is blown away from her.

An improvement of great value meets this need by use of smooth-bore deck guns discharging smoke shells against the submarine, which puts the enemy into a murk screen permitting the merchant ship to escape or, by change of course, to attack the submarine and sink it by gunfire or ramming.[1]

MINES AND TORPEDOES FOR NAVAL OPERATIONS

(e) *Mines*

Ever since the first use of gunpowder in the prosecution of war, mines and torpedoes have received great attention, both from the warrior and the inventor. Mines are either fixed or floating. The fixed or stationary submarine mine is fired by contact, electricity, timing device, or fuse. Such mines, which are extensively used by all navies, are rugged in design and may contain large charges of explosives. They are placed in position by especially equipped mine-laying vessels. Such a mine is provided with an anchoring device.

Floating mines differ from fixed mines in that they are unanchored, and, unless guard boats are at hand to warn friendly vessels of their proximity, may be as dangerous to friend as to foe. Such mines must be, according to laws of war, designed to become inoperative within a few hours after being set adrift.

The submarine has been successfully used as a mine layer and can enter defended sea areas and plant mine fields, uncharted and undetected. An elaboration of this function is noted in the possibility of submarines liberating containers of asphyxiating gases or smoke clouds from a position under the enemy battlefleet or surface ships and causing tremendous loss and havoc.

The defense against such surprise being eternal vigilance and full protection to the crews by night and day use of gas masks.[2]

Harbors and waterways are not entirely safe from submarines that may enter submerged below the mine flotation level to avoid contact, and then rise to the surface for observation and bombardment or to release aeroplanes, for distant depredations.

A proposed harbor defense against the enemy submarine awash or surface battlecraft, comprises a method of gas- or smoke-cloud liberation from containers anchored to the bottom and electrically controlled, or detonated, from shore observation stations, thus involving the enemy in a murk or incapacitating gas cloud.

This camouflage mine field could be cheaply created and would be easy to install; and while depriving the enemy of power of observation or fire control, it would yet disclose his position by his military-mast tops rising above the low-hanging cloud and permit the shore batteries to deliver their attack.

(f) *Torpedoes*

The modern submarine torpedo is about 20 in. in diameter and 20 ft. in length, is self-propelled, is not steered by magnetic means, and keeps a fairly accurate course for several thousand yards at an average speed of more than 30 miles an hour. Its weight is approximately a ton and a quarter, and, when traveling at normal speed, it possesses great momentum; in fact, in one case when the high explosive charge in the warhead failed properly to detonate, the body of the torpedo penetrated the steel hull of the ship attacked. Torpedoes are also provided with means to more or less effectively cut through screens, nets, or guards placed in their path.

A torpedo is projected from a submarine or other vessel by means of a special form of tube or gun. A small charge of gunpowder or compressed air is employed to start the torpedo, after which—if of the usual self-propelling type—it is driven through the water by its own compressed-air motor, the air being supplied from a strongly built reservoir within the body of the torpedo itself. The torpedo is kept upon its course by a gyroscope steering mechanism, which is immune to outside magnetic disturbances.

The detonation of the torpedo is accomplished through a mechanism placed within its warhead; and if the torpedo is either abruptly diverted from its course or is checked in its forward motion, the firing device, which is operated by arrested momentum rather than by any form of a projecting firing pin, instantly ignites the heavy charge of explosive contained within the warhead. The explosion, if it takes place within 20 ft. of the vessel, will usually rupture the ship's plating, because of the terrific blow transmitted through the water from the point of the explosion to the ship's side. The depth at which a torpedo travels . . . is usually between 10 and 15 ft. below the surface.

CONFINING THE SUBMARINES

The question as to why submarines are not destroyed before they reach the open sea is a most natural one, and the best answer which it is possible to give, according to the officers of our navy and those of the foreign commissions who have visited this country, is as follows:

The submarine bases are very strongly protected by land batteries, aeroplane observers, and large areas of thickly mined waters extending to such distances that the largest naval gun cannot get within range of the bases. In spite of these protections, there is now going on a continuous attempt on the part of the allied navies to entrap or otherwise defeat the submarines as they emerge from the protected areas. Nets are laid and as promptly removed by the enemy, whose trawlers are in turn attacked by our destroyers. The design of these nets and the detailed arrangement of their fastenings and attachments offer a broad field for invention, but it should be remembered that they must be capable of being used in waters in which there is a tidal current running from two to five miles per hour. Many suggestions for "bottling up" these bases have been offered, but, as will be realized, it is not desirable to publish information which would indicate even in the smallest degree this country's plans.

Ambitious plans have been presented suggesting a great bomb-curtain sea net, strung in sections miles long and pendant 200 ft. deep, to close the North Sea from Scotland to the three-mile limit off the Norway coast. The difficulties are stupendous and the cost would be tremendous, but many important engineers and the scientific and technical press express hope that it will yet be done. This great net would be float-supported, and at the crosswires of the 20- to 30-ft. meshes there would be attached explosive contact bombs to destroy any submarine that would nose in.[3]

SHIPS AND SHIPBUILDING

Many suggestions are made for ships of unusual form to provide for safety in case of a torpedo or mine exploding near or against the hull. Most of these plans are an elaboration of the usual watertight bulkhead construction now required as structural design for all modern ships.

The multiplicity of watertight compartments in any hull design tends to add to the vessel's safety.

The modern tank steamer used to carry fluid cargoes, such as petroleum products or molasses, is a good example of this design, which has been in general use for many years.

[1] U. S. Patent Application Serial No. 195,289.
[2] U. S. Patent No. 1,222,498.
[3] U. S. Patent Application Serial No. 155,316.
[1] U. S. Patent Application Serial No. 157,389.

The explosion of a nearby submarine mine or torpedo frequently tears great rents in the ship's plating, in some cases opening a jagged hole ten feet or more across, but the destructive effect on the hull of a ship caused by the explosion of a mine or torpedo may be greatly diminished by special hull construction.

The incompressibility of water gives the required fulcrum to the explosion of the warhead, and the hull plates break inward under the impulse of the expanding white-hot gases. It therefore follows that the destructive effect would be minimized in direct proportion to the non-resistance of the fulcrum. To accomplish this desired result an ingenious method is under patent which provides perforated pipe-line outlets parallel to the ship's keel and connected up to the high-pressure steam line.

Upon the approach of a torpedo the steam is switched into the outlets and the rising zone of bubbles displaces the sea water and creates a froth mass of reduced resistance tending in great measure to dissipate the force of the torpedo explosion.[1]

Conclusion

In making reference to various patents and applications of devices, it is only intended thereby to illustrate types and general methods that the engineer and inventor may know in part what has already been done. Even though some of these references may be to the thousands of misconceived devices examined and unused by the Naval Consulting Board, they have been helpful to the national cause as guides and guards to inventors yet unborn.

[1] U. S. Patent Application Serial No. 201,949.

A VOLUME REGULATOR FOR BLAST-FURNACE ENGINES

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Member of the Society

Blast-furnace operation has attained a high degree of refinement in the proportioning of the various materials composing the charge—the ore, the fuel and the flux. The weight of oxygen—introduced as atmospheric air—per charge has, however, until recently been subject to much uncertainty due primarily to the difficulty of measuring with any degree of accuracy the volume of air delivered. The adjustment of the air supply to the furnace was, therefore, usually made only when the operator found evidence that the furnace was badly overblown or underblown, a process which resulted in a more-or-less variable product and certainly in a reduction in the possible maximum output of the furnace.

With the advent of the centrifugal compressor giving a perfectly steady air blast, the metering of the air supply became more practical and, therefore, more usual. With perfectly definite and uniform charging a definite and uniform weight of air per minute is desirable. Constant-volume governors have been designed on two principles, one by metering the air by means of a venturi meter and the other by using an impact float. The venturi-meter governing has been improved by using a multiple venturi meter in which large pressure drop can be obtained in the throat without a corresponding loss in power. This difference in pressure is used on a mercury pot whose motion up and down is translated to the governing mechanism of the driver of the air compressor. The proper setting of this meter is accomplished by changing the tension of the spring until a scale calibrated in cubic feet of air per minute shows that the desired quantity of air is obtained.

In the impact-float method the air is taken through a conical opening in which is suspended a float, this float moving a horizontal beam about a pivot. The horizontal beam actuates the governing mechanism of the driver of the air compressor. On this horizontal beam is a sliding weight which can be set at calibrated marks representing cubic feet of free air per minute. With the weight set in a definite position a certain definite quantity of air is obtained.

In both of these methods, however, the readings on the calibrated scale are only correct when the initial air conditions are standard, that is, are similar in barometer, temperature and humidity to which the scale has been calibrated. Any change in either the temperature of the inlet air or in the atmospheric barometer or in the humidity of the air, changes the weight of the air metered, and, therefore, its oxygen content. As the blast furnace requires an exact weight of oxygen, the above method of holding constant volume is liable, in extreme cases, to have an error of from 15 to 20 per cent.

A volume corrector is herewith presented which when used in connection with the air-metering device will correct for any changes in temperature, barometer and humidity, so that the air supplied to a blast furnace will, at all times, under any atmospheric conditions, deliver a perfectly definite and predetermined weight of oxygen to the blast furnace. This volume corrector is so designed that it requires only one setting for each correction, that is, one setting for any initial temperature, one setting for any existing barometer and one setting for humidity as usually obtained by the difference of readings on a wet- and dry-bulb thermometer.

THE blast furnace is primarily an apparatus for producing pig iron; but incidentally it may also be regarded as a huge gas producer. The materials fed to it are the iron ore, the fuel (coke), and the fluxes (limestone), which are charged at the top of the furnace or throat; and the air blast, which is blown in near the bottom of the furnace at the tuyeres. The materials discharged from the furnace are pig iron and slag, which are tapped from the bottom or crucible of the furnace, and the gases and dust, which pass out of the top of the furnace. The iron ore in a blast furnace is deoxidized or reduced, for which purpose the furnace is charged with sufficient carbonaceous fuel to do two things: to abstract all the oxygen from the reducible metallic oxides and to furnish enough heat at high enough temperature to melt down to superheated liquids the pig iron and slag—combinations of irreducible metallic oxides—that are formed. The fuel must supply the reducing energy and the melting-down or smelting requirements; the first by action upon the metallic oxides at a red to a white heat and abstracting their oxygen; the second by being burned at the foot of the furnace by the hot-air blast, and there generating the heat and higher temperatures necessary for the smelting down of the materials already reduced.

In a secondary way the blast furnace may also be regarded as a huge gas producer, run by hot forced blast, in which the incombustible portions of the contents are melted down (with a little unburnt carbon) to liquid metal and slag and are run

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out beneath, while the gaseous products pass upward through 50 to 100 ft. of burden and escape above. The escaping gases are primarily of the composition of producer gas, with some of its carbonous oxide changed to CO_2 by the oxygen abstracted from the burden; with some CO_2 added from the decomposition of the carbonates of the charge: and with the usual increment of moisture from the charge and volatile matter (if any) from the distillation of the fuel. Hence, the blast furnace is a huge gas producer, giving a rather inferior quality of combustible gas in large quantities, while reducing to metal and slag the burden of iron ore and flux (limestone) which is put in with the fuel. In fact, the unoxidized and combustible ingredients of the escaping gas represent a large part, often the largest part, of the total calorific power of the fuel.

Air Requirements in Blast Furnaces

From the above it can be readily seen that if the charging of a furnace is uniform, it is quite essential to have the amount of air supplied to the furnace also uniform in quantity. The air pressure required for forcing the air through the furnace varies with the condition of the burden or charge. If the particles of ore, fuel, and limestone are large, that is, the spaces between these particles ample, there is a freer passage for the air than if the particles of ore, fuel, and limestone are small and closely packed. Under certain conditions the furnace may require a pressure of, say, 10 to 15 lb. to force a certain quantity of air through it, while under other conditions, when the material in the furnace is tightly packed, a much higher pressure, sometimes as high as 25 to 30 lb., is required to force through the same amount of air.

Air Compressors for Blast Furnaces

It is therefore absolutely necessary that the air compressor be capable of adapting itself automatically to supply a predetermined *weight* of air, corresponding to the charge in the furnace, regardless of the resistance encountered up to a certain prescribed maximum. Usually the limiting air pressure is 30 lb., as this is the maximum pressure the stack itself will withstand with safety.

The expression *weight of air* is used advisedly, because the blast furnace requires a definite weight of oxygen to combine with the carbon in the coke charged to the furnace. In general practice we refer to this definite weight of air (or oxygen) as a "constant volume of air," but this volume must have reference to specific conditions of temperature, barometer and humidity, because any variation of these conditions changes the weight of oxygen contained in a given volume. The standard conditions most commonly referred to are dry air at 60 deg. fahr. temperature and 30 in. barometer. Air under these specified conditions contains, of course, a perfectly definite weight of oxygen per cubic foot.

Reciprocating Engines and Blowers

Up to the advent of the centrifugal compressor, reciprocating compressors were chiefly used for blast-furnace work. The governor of the compressor driver was set to maintain a speed corresponding to the desired quantity of air, the general idea being that each stroke of the compressor represented a practically constant quantity of atmospheric air regardless of the discharge pressure.

The r.p.m. of the reciprocating compressor was, however, but a poor guide as to the weight of air supplied, and it was left to the judgment of the blast-furnace operator as to whether or not the furnace was receiving the proper amount of air. If in his opinion the furnace was receiving too little air, that is, if it was underblown due to the charge in the furnace offering more resistance to air flow than previously, he would call for a higher speed of the reciprocating compressor. Speeding up the driver would then furnish a somewhat greater quantity of air at the higher pressure. If, however, the blast furnace was overblown, the reciprocating compressor was slowed down, and the quantity of air furnished was reduced. This method of operating, however, necessitated a decided change of condition in the furnace before the furnace operator knew that the air supply to the furnace was not correct, and in many cases the furnace got into a very poor condition before the operator changed the air supply and improved conditions.

With the gradual introduction of greater refinements in determining the quantities and the chemical composition of the ore, fuel and flux entering each charge in the blast furnace, the uncertainty in the quantity of air supplied began to stand out more and more as the weakest link in the chain. There was not only the need for a reliable method for measuring the quantity of air, but engineers were asking for apparatus which,

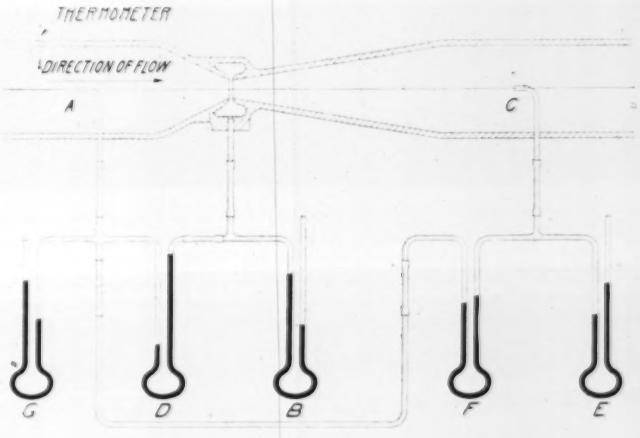


Fig. 1 Venturi Meter

Readings on U-tubes *B* and *D* and of the barometer are necessary

while metering the air, would also automatically maintain constant any desired quantity, regardless of the furnace conditions.

[The paper here reviews briefly the underlying theory and formulæ for the flow of gases, and then enters into the following discussion of the commercial methods of regulation of air to the blast furnace.—Editor.]

Commercial Methods for Measuring Air

The commercial methods for measuring air most commonly employed are: (1) The Receiver Method, (2) The Orifice Method, (3) The Pitot Tube, (4) The Venturi Meter, and (5) The Impact-Float Method. Of these the first two methods waste the air they pass, and are therefore suitable only for temporary testing purposes. The other methods allow the air to pass to destination, and may therefore be left continuously in the system.

In the Receiver Method the compressed air is passed into a closed system consisting of a tank and piping of known dimensions and full originally of air of atmospheric pressure and temperature, which conditions are taken as standard. After the compressed air has been flowing into the system for

a sufficiently long period, say, half an hour or an hour, the pressure and the temperature are again observed.

In the Orifice Method the compressed air is allowed to discharge into the atmosphere through an orifice of known area and known velocity coefficient. The initial temperature is measured by means of a bare thermometer inserted through the wall of pipe immediately preceding the orifice without well or casing of any kind. The pressures may be observed independently, or, preferably, the pressure drop may be observed by means of an impact tube.

Next to the Receiver Method, the Orifice Method is the most certain and the most reliable method for measuring air, and it is therefore generally recommended as the standard for the calibration of other air-measuring methods. A uniform rate of flow, however, is presupposed, as a pulsating flow, such as comes from reciprocating or positive-pressure compressors, cannot be measured reliably by any method which depends on a density × velocity^2 observation unless the discharge piping is of an extreme length sufficient to dampen out all pulsations.

The Venturi Meter shown diagrammatically in Fig. 1 con-

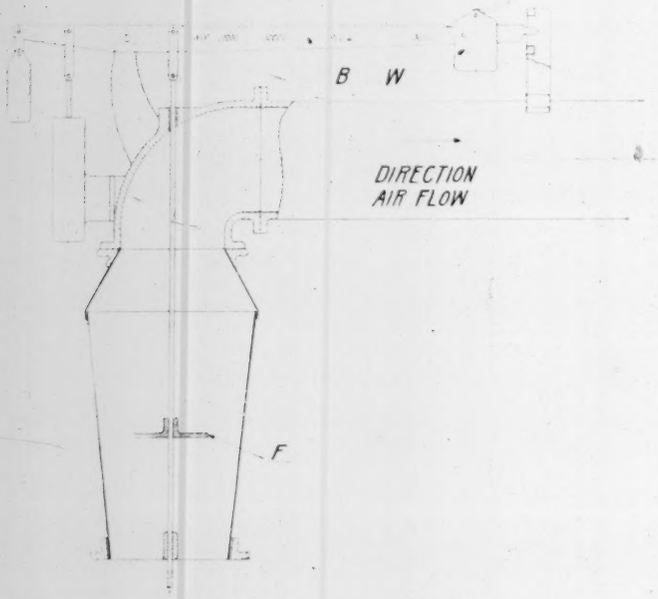


FIG. 2 IMPACT FLOAT AIR METER

sists essentially of a direct and a reversed nozzle placed throat to throat, making a common throat. In general, two U-tubes B and D, or the equivalent, are necessary, one to give the static pressure B in the throat and the other to give the pressure drop D from the main pipe, or high-pressure region, to the throat. It will be noticed that the impact tube A points upstream, so as to include whatever velocity head may exist in the main pipe. After the air passes the throat, the pressure rises again to nearly, but not quite, its original value. This may be demonstrated by the use of impact tube C, pointing upstream, in the pipe beyond the throat. U-tube F communicating with both impact tubes A and C will give directly the pressure loss caused by the insertion of the venturi meter into the system.

The direct nozzle should be short and well rounded, while the reversed nozzle should be well tapered with a half angle of about 4 deg. The inside of the meter must be smoothly finished, and particular care must be taken at the entrance of the U-tube into the throat of the meter to avoid all burrs and roughness. Also the impact tube in the main pipe should be small to avoid any eddies and disturbances due to the introduction of the impact tube.

The quantity of air may be computed from

$$Q = (423fa/\sqrt{T_1})\sqrt{[P_2(P_1 - P_2) - 0.0665\,(P_1 - P_2)^2]} \quad [1]$$

where

Q = cu. ft. of standard air (14.70 barom. and 60 deg. fahr.) per min.

T_1 = absolute temperature in main pipe in deg. fahr.

f = velocity coefficient of throat, usually between 0.95 and 0.99

a = area of throat in sq. in.

P_1 = absolute initial (high) pressure in inches Hg

P_2 = absolute pressure in throat in inches Hg

$P_1 - P_2$ = pressure drop.

In designing a venturi meter for a particular case, the area a is so chosen that the value of $P_1 - P_2$ for the quantity of air most commonly used should be large enough to be read conveniently and with reasonable accuracy and yet not so large as to cause an excessive pressure drop and power loss in the meter.

It is preferable to measure the air before it is compressed, so that P_1 and T_1 are the atmospheric pressure and absolute atmospheric temperature, respectively. A single U-tube like U-tube B in Fig. 1 is then sufficient. The actual pressure P_1 must be obtained from the existing barometer and then P_2 can be computed from the reading $P_1 - P_2$ on the U-tube.

The U-tube can also be calibrated in cubic feet of air per minute instead of indicating only inches of mercury pressure. When so calibrated it can only refer to some standard or average condition of air, and any change in temperature, barometer or humidity will affect the correct reading on such a calibrated scale.

IMPACT-FLOAT METHOD

The Impact-Float Method described previously in a paper by Mr. R. H. Rice before this Society and illustrated in Fig. 2 consists in allowing the air to be metered to impinge on a float F, usually in the form of a disk, suspended vertically in a cone. The air enters the small end of the cone, and its velocity is steadily reduced as it passes up toward the larger end of the cone. The force tending to lift the float, and whatever is attached to it, against gravity consists partly of the direct impact of a part of the air against the float, and partly of the pressure drop caused by the passage of the air through the annulus between the float and the cone in a sort of *vena contracta*. As the float rises in the cone, this force is reduced by the lowered velocity of the air, so that the position of the float in the cone is a function of the quantity of air passing through the cone.

It is desirable, however, for reasons which will appear later in connection with air regulation, to confine the position of the float within narrow limits, regardless of the quantity of air. This is accomplished as shown in Fig. 2 by connecting the float to a horizontal lever or beam B, the force on the float being balanced by a sliding weight W, which can be moved to any part of the beam. The beam is so graduated that the position of the sliding weight on it gives directly the volume of the air entering the cone.

The impact on the float or the momentum of the air is evidently mV, where m is the mass of air impinging on the float per second and V is its velocity. Since for a constant cross-section m is proportional to γV, where γ is density of the air, the impact on the float is proportional to γV^2 or to m^2/γ. Similarly, the pressure drop through the annulus around

the float is $\gamma V^2/2g$, where V is now the velocity in the annulus, and is therefore also proportional to m^2/γ.

When the air flows through the annulus between the float and cone a *vena contracta* obtains whose area varies with each volume of air flowing. On account of this, formulæ for the float force or reaction based on purely mathematical deductions require modification based on experimental results. The slope of the cone and the ratio of float diameter to cone diameter and also the average velocity of the air through the cone in uence the value of this float force. For long cones having a slope of about one inch in five inches and with floats having areas between 50 per cent and 95 per cent of the annulus area and using average velocities through the cone under 100 ft. per sec., the following formula found experimentally will hold:

$$F = 9 \times 10^{-4} Q^2 \gamma \sqrt{(A/a^2)} \quad \ldots\ldots\ldots\ldots [2]$$

in which

F = total force of float in lb.
Q = cu. ft. of air per min.
γ = density of the air in lb. per cu. ft.
A = float area in sq. ft.
a = annulus area in sq. ft.

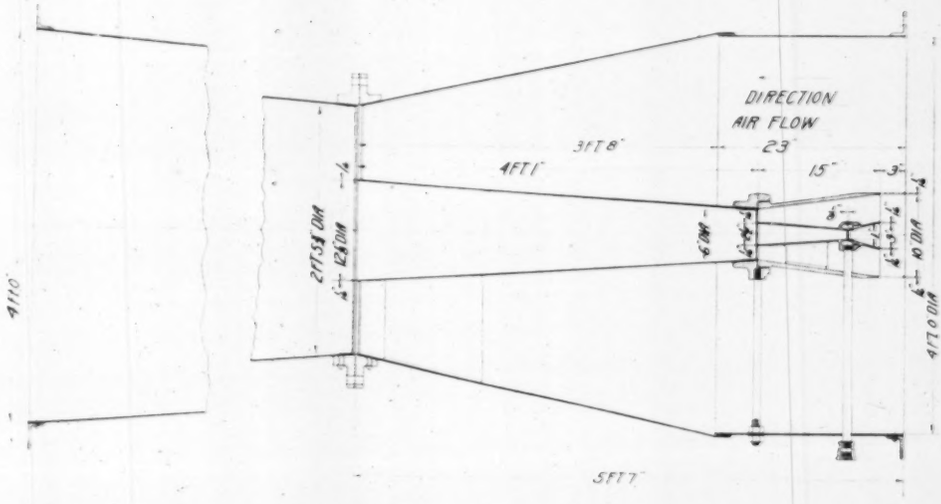


FIG. 3 TRIPLE VENTURI METER

Used for securing a reasonable drop of pressure without excessive power loss

The upward moment of the force F about the fulcrum of the beam (Fig. 2) is counterbalanced partly by the downward moment of the weight of the float and partly by the moment of the sliding weight, which is downward, but may be upward for small volumes of air. In any case, however, the system may be reduced to one having a weightless float and beam, so that the upward moment of the float force F is balanced by the downward moment of the sliding weight W. Since both the weight W and the lever arm of F are fixed, the lever arm of W must be always proportional to the force F, or to M^2/γ, in which M is Q referred to standard conditions of barometer, temperature and humidity, and therefore represents a definite weight of air.

In other words, the beam must have a quadratic scale; that is, the longitudinal distance of the sliding weight from the zero on the beam is four times as great for 20,000 cu. ft. and nine times as great for 30,000 cu. ft. as it is for 10,000 cu. ft. The graduations on the beam are made correct for the average atmospheric conditions of the air at the place where the instrument is to be used.

In metering the air all that is necessary after the beam is calibrated is to move the sliding weight W along the beam until the beam is level, exactly as in the case of the beam on a pair of beam scales. The pointer on the weight W then indicates the amount of air flowing.

CONSTANT-VOLUME GOVERNING

Of the above-mentioned methods of measuring air in general, only the last two, the Venturi Meter and the Impact Float, are commercially used for regulating the supply of air to blast furnaces. With the advent of the centrifugal compressor a blowing apparatus became available which could be very nicely regulated in respect to holding any constant volume of air supply to the furnace. The centrifugal compressor delivers an absolutely steady stream of air without any pulsations whatever, and the pressure delivered by such a unit varies closely with the square of its speed. Hence, any volume regulation of air need only influence the speed of the driver of the centrifugal compressor. Up to a very short time ago all volume regulation for centrifugal compressors was based upon a calibrated scale for some standard condition of air, usually assumed as dry air at the average temperature and barometer existing at the location of the set. We again emphasize here the fact that constant-volume governing is referred to, whereas the object desired is to introduce a constant *weight* of oxygen into the furnace.

The governing of a centrifugal compressor, in order to hold constant volume, requires the use, first, of a meter for measuring the volume of air flow. The necessary qualifications of such a meter, taking into consideration the large quantities of air used in blast-furnace operation, are: (1) It must not waste any of the air it meters; (2) the power consumed in the metering and governing processes must be small, which makes it necessary that the friction losses of air flow through the meter be small; (3) the governor must be sensitive, so that a small change in the quantity of air supplied will be sufficient to actuate the governor.

THE MULTIPLE VENTURI METER

An ordinary venturi meter in which the entire quantity of air flowing must be drawn through a sufficiently small throat to give a suitable drop of pressure would involve considerable power loss. To reduce this power loss a multiple venturi has been devised, consisting of a number of concentric venturis.

Referring to Fig. 3, which shows a multiple venturi, a very small part of the total air flow passes through the small or inner venturi. At the throat of this small venturi the largest pressure drop is obtained. A larger quantity of air flows around the inner venturi and through the second venturi, but the bulk of the air flow is around the second and through the third or outer venturi.

Consider a flow of 45,000 cu. ft. of standard air per minute through the triple venturi shown in Fig. 3, the air flowing from right to left as indicated. The air at inlet to the venturi is assumed to be at practically atmospheric pressure and temperature. By the use of Equation [1] and by assuming a probable velocity coefficient $f = 0.95$ for the inner venturi and $f = 0.85$ for the two outer venturis, we can show that the following conditions obtain. Through the inner venturi 175.8 cu. ft. of standard air flows. The pressure at the throat is 22.65 in. Hg, representing a drop of pressure of 7.28 in. Hg. About 1777 cu. ft. of standard air per minute flows through the middle venturi. The drop of pressure from atmosphere to the throat of this venturi is 0.73 in. Hg. All the remaining air (43,047 cu. ft.) passes through the outer or third venturi, and the drop of pressure from atmosphere to the throat of this venturi is 0.69 in. Hg.

The loss of power in metering the air through this triple venturi, when passing 45,000 cu. ft. of standard air per minute, can be determined from the loss of pressure between that existing at the entrance to each venturi and the pressure existing at the exit or discharge end of each venturi, taking into account the volume of standard air passing through each. This gives a loss of power of 0.18 hp. for the smaller or inner venturi, 1.06 hp. for the middle venturi and 31.38 hp. for the outer or largest venturi, making a total power loss through the entire triple venturi of 32.62 hp.

The largest drop of pressure in this triple venturi meter occurs in the throat of the inner or smallest venturi. With a flow of 45,000 cu. ft. of standard air per minute, the calculated drop is 7.28 in. Hg (3.57 lb. per sq. in.) pressure. With air entering the meter from atmosphere, the throat pressure will be negative (suction). With varying flow of air through the venturi, the suction at the throat of the inner venturi will also vary; and this varying suction can be used for governing the driver of a centrifugal compressor so as to hold a definite "*constant volume*" of air flow per minute.

THE VENTURI METER CONSTANT-VOLUME GOVERNOR

Fig. 4 shows in a somewhat diagrammatical manner a means for accomplishing this. The pipe leading from the throat of the inner venturi meter is connected to part *A* representing a mercury-sealed pressure bell, or mercury pot. Suction pressure at the venturi throat is established in the space *B* between the stationary part of the pot and the upper and movable bell.

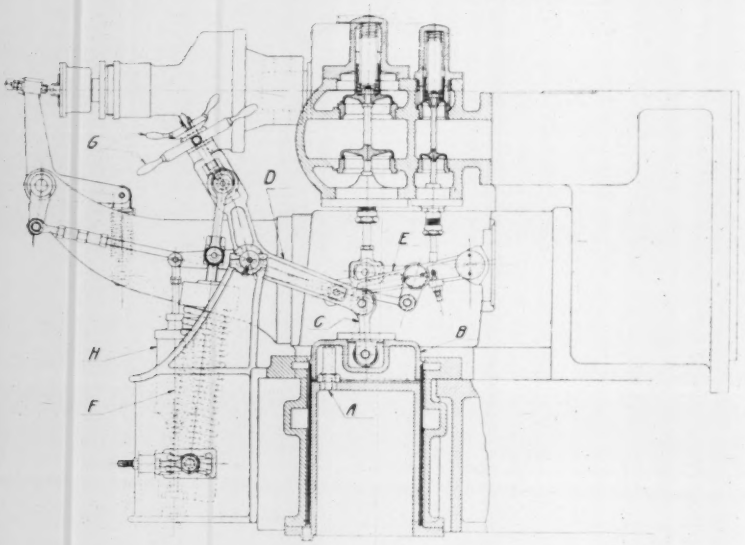


FIG. 4

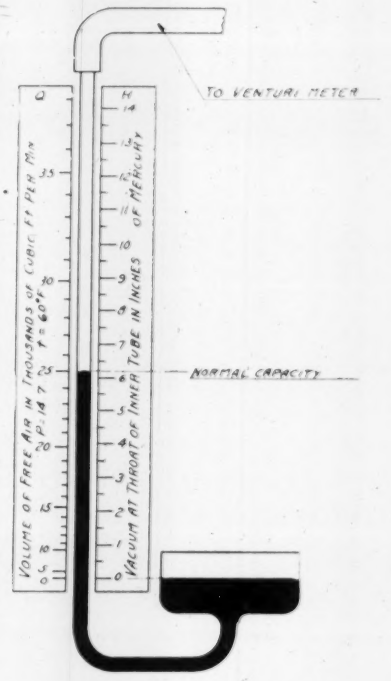

TO VENTURI METER
NORMAL CAPACITY
VACUUM AT THROAT OF INNER TUBE IN INCHES OF MERCURY
VOLUME OF FREE AIR IN THOUSANDS OF CUBIC FT PER MIN AT 29.92 IN. BAR. AND 60° F.

FIG. 5

FIG. 4 CONSTANT-VOLUME GOVERNOR FOR VENTURI METER. FIG. 5 U-TUBE AND QUANTITY SCALE FOR VENTURI METER

FIG. 4. Uses a mercury pot subjected to the pressure of the throat of the venturi meter shown in Fig. 3 and with adjustments so that it can hold any desired volume as indicated on a calibrated mercury tube shown in Fig. 5.
FIG. 5. Used with a venturi meter as shown in Fig. 3 and with a constant-volume governor as shown in Fig. 4.

Variations of pressure in *B* cause this bell to move up or down. The suction pressure is sealed from atmosphere by a column of mercury surrounding the long sheet-steel skirt or extension of the bell. There is sufficient clearance space between this sheet-steel skirt and the inner and outer shell surrounding it to prevent any frictional contact. The movement of the bell in the mercury pot is transmitted through the links *C*, *D*, and *E* to the steam-valve control to the turbine, thereby opening and closing the number of valves admitting steam to the turbine. An adjustable spring *F* can be set so as to counterbalance the pull of the bell for any desired volume of air. Handwheels *G* are used for setting the spring tension, as can be readily understood from the figure. Dashpot *H* dampens out the oscillations of this gear.

The method of setting for regulation is as follows: Having determined exactly the number of cubic feet of standard air desired per minute, the operator turns the handwheel *G* and observes the height of the registering mercury column, also attached to the pipe leading from the throat of the inner ven-

turi. This mercury column is not only inscribed in inches of mercury, but is also calibrated in cubic feet of air per minute, as shown in Fig. 5.[1] When the mercury column registers the desired number of cubic feet of standard air per minute, handwheel G is locked. Any change in air flow through the venturi will change the suction in the pipe leading from the throat of the inner venturi to the mercury pot shown in Fig. 4, and also to the gage in Fig. 5. A change of suction on the mercury pot, however, influences the governing mechanism so as to increase the steam admission to the turbine when the suction decreases, or decrease the steam admission to the turbine when the suction increases. By this means constant-volume governing is obtained. Increasing the steam admission to the turbine speeds up the unit, thereby increasing the discharge pressure of the compressor, and vice versa. Equilibrium must be established between the spring tension set by handwheel G and the pressure in the confined space in the mercury pot before the governing mechanism comes to rest.

The calibration of mercury column indicating number of cubic feet of air per minute refers to standard air, that is, air of the average temperature and barometer and humidity for which the unit has been calibrated. Fig. 5 shows a calibrated scale for a normal capacity of 25,000 cu. ft. of air per min., whereas Fig. 3 shows a multiple venturi of a much greater normal capacity, probably 40,000 cu. ft. per min.

THE IMPACT-FLOAT CONSTANT-VOLUME GOVERNOR

The second method for regulating turbo-compressors for blast-furnace work involves the use of the impact float which was originally conceived as part of the means for constant-volume governing. Fig. 2 shows the impact float suspended in a conical pipe and attached to a beam calibrated in cubic feet of air per minute. If this beam were attached by linkages to the governing mechanism of the driver of a centrifugal compressor, it could be made to take care of its governing.

Fig. 6 shows such a constant-volume governor. Float F is suspended by a vertical rod from beam B. The float is made so it can be heated with a small amount of compressed air introduced through the hollow suspension rod S so as to prevent moisture from condensing and freezing upon the float in winter. The beam is fulcrumed at A and is balanced by counterweight C and movable sliding weight W. Dashpot D prevents too rapid movements or oscillations. Handwheel H on one end of the beam moves the sliding weight W longitudinally along the beam by means of a threaded shaft and nut. The sliding weight can thus be set at any definite position indicating the desired volume of air per minute. Any movement of the beam is transmitted through linkages M, N, O and T to a controlling pilot valve V which will admit steam or oil under pressure to either one or the other side of a piston P. This piston is connected directly to a nest of controlling valves which admit steam to separate groups of turbine nozzles. The turbine governor G is used as a speed-limiting device, so arranged that when the turbine reaches a speed corresponding to that at which the compressor would deliver the maximum permissible pressure (for blast-furnace work usually 30 lb. per sq. in. gage), it moves linkages L, K, and N and thereby influences the governing pilot valve from opening more valves for steam admission. In other words, at this speed it takes the control of the turbine out of the hands of the constant-volume governor.

[1] For Figs. 3, 4 and 5 the author is indebted to the Southwark Foundry and Machine Company.

The important feature of this method of constant-volume governing is the very small pressure drop involved by the air passing through the conical pipe of the meter. The area of the float is so large that a very low velocity of air and an extremely small pressure difference on the two sides of the float is sufficient to afford all the force necessary to move the entire governing mechanism. This fact also makes the governor sensitive to the smallest variation in the quantity of air passing through the compressor.

The force exerted upon the impact float when used as a constant-volume governor can be determined from Equation [2].

It has been found advisable to make the area of such a float equal to

$$A = 700(Q_1^2/Q)[1 - \sqrt{(p\gamma)}] \quad \ldots\ldots\ldots\ldots [3]$$

in which

A = area of float in sq. ft.
Q = correct quantity of cu. ft. of standard air per minute for a definite position of sliding weight
$Q_1 = Q + q$
q = smallest change of volume in cu. ft. of air per min. desired to produce an effect governing
γ = density of air in lb. per cu. ft.
p = mean effective pressure in lb. per sq. in. for which the compressor has been designed.

It will be noticed that the smaller the value of q, the more sensitive will be the governing and the smaller will be the force available for governing purposes. If q is taken reasonably large the governing forces become greater, but the constant-volume governor will be less sensitive. In other words, q is a measure of the per cent of the regulation desired.

When the float is in proper position for the compressor to deliver its normal rating of air against the normal pressure, the annulus area between the float and the cone may be found from the following equation:

$$a = 0.0017Q\sqrt{(\gamma/P_m)} \quad \ldots\ldots\ldots\ldots [4]$$

in which

a = annulus area in sq. ft.
Q = the normal rating of the compressor in cu. ft. of air per min.
P_m = the mean effective pressure corresponding to the normal pressure rating in lb. per sq. in.
γ = density of air in lb. per cu. ft.

It is advisable to make the inlet-pipe diameter for supplying atmosphere air to the constant-volume governor and hence to the compressor of such diameter as to limit the velocity of air to approximately 30 ft. per sec. The constant-volume-

TABLE 1 FLOAT AREAS AND FORCES USED IN IMPACT FLOAT METHOD

Normal rating of unit, cu. ft. of standard air per min.	Quantity of air delivered, cu. ft. per min.	Float area, sq. ft.	Float force, lb.
50,000	45,000	7.43	168
40,000	40,000 35,000	6.87	167 128
30,000	30,000 25,000	4.90	171 118
20,000	22,500 20,000 18,300	3.14	112 89 75

governor cone should extend into an inlet box which would admit air with uniform distribution into the cone. It is therefore advisable to have the inlet box as large as possible.

Table 1 gives an idea of the float forces and float areas employed in practice, the float force having been measured experimentally in each case.

INACCURACIES OF CONSTANT-VOLUME GOVERNORS

Both the venturi-meter and the impact-float methods of constant-volume governing applied to centrifugal compressors have resulted in improving the regulation of blast furnaces. Unfortunately, this means of regulating cannot be applied to any other type of air-compressing machinery because all other known types of compressors do not produce an absolutely steady flow of air. The advent of constant-volume governing has eliminated the only remaining guesswork heretofore employed in regulating the air supply to a blast furnace. With careful analysis of the iron ore and coke charged to the furnace and a careful weighing of them as they are charged, the amount of oxygen necessary for combustion of the coke and reduction of the iron ore is accurately and easily determined. It is then only necessary in the venturi method to adjust the governing mechanism so that the indicating mercury column shows the desired quantity of atmospheric air per minute; or, in the impact-float method, merely to set the sliding weight on the governing beam to the indicated quantity of atmospheric air desired. In the latter case the weight can be set immediately and the governor will automatically establish the proper air flow, whereas, in the former case, adjustment must be made slowly until the desired air flow is obtained. In both cases, however, if the atmospheric conditions of the inlet air change from the so-called standard or average conditions for which the governors were calibrated, the actual quantity of air delivered, or more correctly, the actual *weight* of oxygen sent to the blast furnace, will vary. This variation may be considerable.

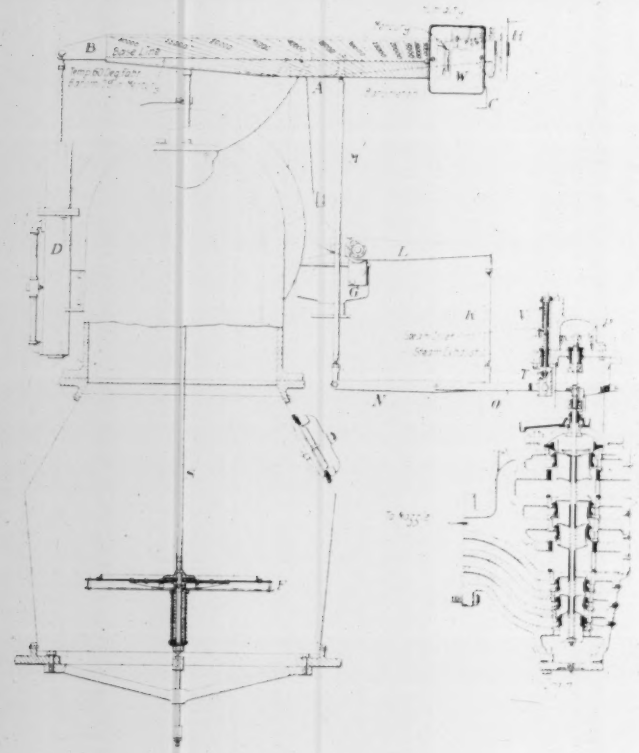


FIG. 6 VOLUME CORRECTOR

Shown mounted on the beam of a constant-volume governor

For instance, if the standard air conditions are taken as dry air at 60 deg. fahr. and 29 in. Hg and the governor is calibrated for these conditions, it is possible to conceive a summer condition of 100 deg. fahr. with a barometer of 26 in. and fully saturated air (as on a rainy and stormy day). There is 14 per cent less oxygen per cubic foot of air under these conditions than under standard conditions. In winter, atmospheric air may be at 0 deg. fahr., the air perfectly dry and a barometer of 30 in. Hg. A cubic foot of this air will contain 8 per cent more oxygen than the standard air. It is, therefore, perfectly possible to supply from 8 per cent too much oxygen to 14 per cent too little oxygen to the blast furnace, if regulation is dependent on constant-volume-governor settings of standard or average conditions of atmospheric air.

THE VOLUME CORRECTOR

The main object of this paper is to describe a new instrument named a volume corrector which can be applied to the sliding weight and calibrated scale of an impact-float constant-volume governor for correcting this governor when handling air of any temperature, barometer or humidity. An instrument similar in principle and somewhat similar in construction can also be applied to the indicating mercury column of the venturi meter so as to obtain proper volume correction.

The volume corrector applied to the impact-float constant-volume governor is shown in Fig. 6. The scale beam *B*, instead of having vertical calibration lines for standard conditions of air, has sloping constant-volume lines engraved upon it. The volume corrector proper is mounted on the front of the sliding weight *W*. Fig. 7 is a photographic view of a part of this scale beam with volume corrector mounted on the sliding weight; and Fig. 8 is the same with the hinged door of the volume corrector open, as is the case when the instrument is to be set.

Fig. 9 shows a little more clearly the arrangement of this instrument. There are three milled heads, *A*, *B*, and *C*, provided for adjusting pointers indicating barometer, temperature and humidity. All that is required of the operator is to set these pointers correctly. After obtaining the actual barometer reading from a standard barometer, and the actual temperature of the incoming air, and observing the existing humidity—which is usually done by noting the temperature difference between a wet- and dry-bulb thermometer, pointer *a* is set at the proper barometric reading, pointer *b* at the proper temperature reading, and pointer *c* moved so as to intersect the curve corresponding to the observed temperature difference between the wet- and dry-bulb thermometers.

The movement of each of these pointers influences the final position of the main pointer *P*. This main pointer moves in a vertical direction with respect to the scale on the beam. After the volume corrector is properly set, the sliding weight to which the volume corrector is permanently attached is moved horizontally along the beam until the main pointer *P* intersects the sloping line on the graduated scale designating the proper volume of standard air required. When so set the sliding weight is in the proper position. This permits corrections to be made for variation in temperature, barometer and humidity so that a constant *weight* of oxygen is supplied no matter what the conditions of the atmospheric air. Having determined that the blast furnace requires a definite volume of standard air (dry air at 60 deg. fahr. and 29 in. Hg), the

governor with corrected setting of the sliding weight will deliver the proper amount of actual air which would contain the same *weight* of oxygen as would be contained in the required quantity of standard air.

The amount of oxygen in dry air varies directly as the density of the air. The density of air is directly proportional to the barometric pressure and inversely proportional to the absolute temperature. Expressed symbolically, $\gamma \propto B \div T$. As the lost force is proportional to $M \cdot \gamma$, a change in density γ with the governor set to maintain a constant weight M of air per second will cause the governor to change the speed of the compressor until a new weight M_1 is delivered, such that the new value of $M_1 \cdot \gamma_1$ is the same as the original value of $M \cdot \gamma$. Expressed symbolically, for a given setting of the sliding weight, $M \propto \gamma$, or $M \propto B \div T$. For moist air the barometer no longer represents the pressure of the air itself, for part of the barometric pressure is due to the vapor pressure in the air. This vapor pressure must therefore be subtracted from the observed barometric pressure in order to get the net air pressure to be used in computing the air density and hence the weight of oxygen per cu. ft. of air. For saturated air (a relative humidity of 100 per cent) the vapor pressure can be read directly from steam tables for the observed atmospheric temperature. If the air is not quite saturated, the relative humidity, or the percentage of the possible maximum of moisture in the air, can be determined in a number of ways; usually, from a dry- and wet-bulb thermometer arrangement. The vapor pressure for a given temperature is proportional to the relative humidity, and this must then be subtracted from the observed barometric pressure in computing the air density.

The graduated scale on the beam of the constant-volume governor was designed by taking a horizontal base line such as was shown in Figs. 6, 7 and 8, and shown schematically in Fig. 10 as AA', and placing thereon the proper calibration for standard air (dry, 60 deg. fahr., 29 in. Hg). The zero on this line gives the position of the sliding weight when the constant-volume governor beam is in equilibrium and no air is flowing. The point B (Fig. 10) represents the position of the sliding weight for 10,000 cu. ft. flow; and point C its position for 20,000 cu. ft. flow, etc. The distance AC is made equal to four times AB. Similarly the distance AD, where D represents the 30,000 cu. ft. point, is made equal to nine times AB. With respect to temperature, the graduations on AC hold good so long as the prevailing atmospheric temperature is 520 deg. fahr. absolute. When the prevailing temperature is other than 520 deg. fahr. absolute, the relations of the distances AB, AC, AD to each other remain unchanged; but they must all be multiplied or foreshortened by the same ratio. This is accomplished in the following manner:

Referring to Fig. 10, let the line OAB' be perpendicular to the base line AA'; and let OA represent to some scale 520 deg. fahr. absolute, and OB' represent 2080 deg. fahr. absolute to the same scale, so that $OB' = 4\ OA$. Draw $B'C'$ parallel to AA' and CC' parallel to OB'. Also prolong the straight line OB until it intersects the line $B'C'$ in the point P (not shown). The triangles OAB and $OB'P$ being similar, $B'P : AB :: OB' : OA$; or $B'P = 4\ AB$. But $B'C' = AC = 4\ AB$. Therefore $B'P = B'C'$; or P coincides with C'. In other words, the intersection C' of the line CC' with $B'C'$ is a point on the straight line OB.

Now in actual operation when the governor is set to deliver 20,000 cu. ft. of standard air per minute for a temperature of 520 deg. fahr. and should the actual temperature be four times as high, or 2080 deg. fahr. absolute, the governor will, as explained before, with the same setting of the sliding weight, regulate for only 10,000 cu. ft. of standard air per minute, because the density of the air at 2080 deg. fahr. absolute is one-fourth of that at 520 deg. fahr. absolute. The pointer of the sliding weight must under those conditions then read 10,000 cu. ft. without the sliding weight itself being disturbed in any way. In the volume corrector this would be accomplished by pushing up the final pointer along a uniform temperature scale until it reads 2080 deg. fahr. absolute, because the pointer traveling upward would then, as proved above, just intersect the 10,000 cu. ft. line $OB'C'$. It will be noticed that all the

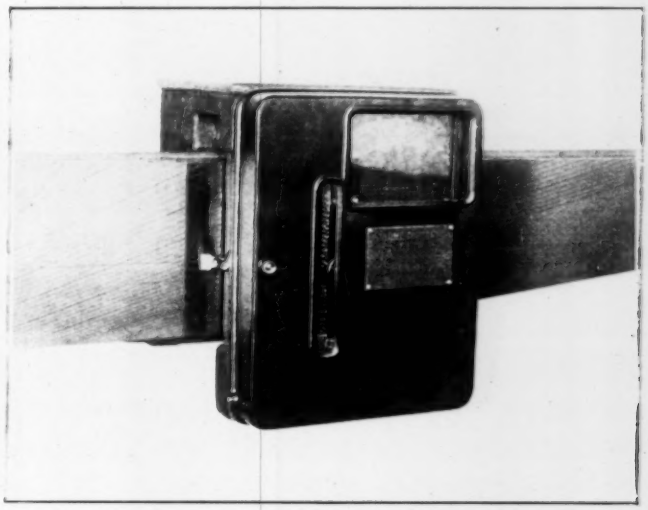


FIG. 7 PHOTOGRAPHIC VIEW OF THE VOLUME CORRECTOR
Front door of casing closed

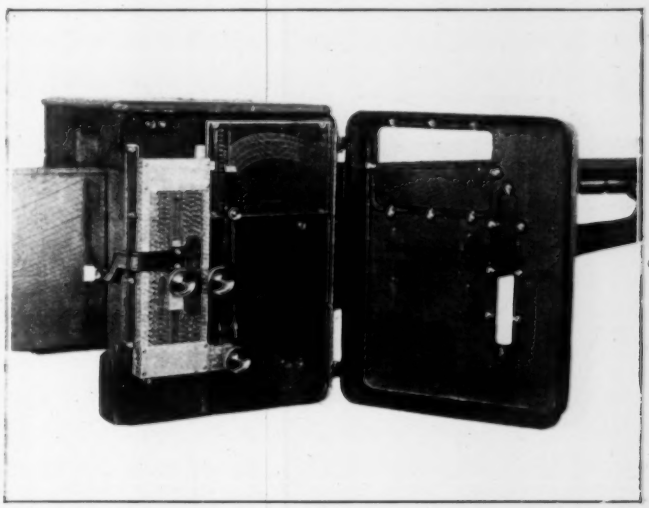


FIG. 8 PHOTOGRAPHIC VIEW OF VOLUME CORRECTOR
Front door of casing opened

sloping lines representing definite volumes of air per minute meet at O. This would represent the point of absolute zero if the same temperature scale was carried down on the prolongation of the line AB. From the above it can be seen that if the volume corrector be made to carry a temperature scale with the same distances as employed in the engraving of the scale on the beam, and the main pointer P of the volume corrector be made to move vertically up and down the proper distance to this scale, the sliding weight can be set for any observed temperature of atmospheric air so as to deliver the proper volume of air containing the same weight of oxygen as is

contained in the previously calculated necessary volume of air of standard conditions.

Further consideration will show that as far as the density or the square of the volume is concerned, doubling the absolute temperature is equivalent to halving the barometer. In other words, any barometric change can be expressed by an equivalent temperature change. For instance, if 29 in. Hg is taken as the standard barometer and 60 deg. fahr. (520 deg. absolute) as the standard temperature, a change to 28 in. barometer, the temperature remaining at 60 deg. fahr., is equivalent to a change to a temperature of (29 × 520) 28 or 538.6 deg. fahr. absolute (78.6 deg. fahr.) with the barometer remaining at 29 in. Hg. The distance on the barometer scale from 29 in. to 28 in. must therefore equal the distance from 60 deg. fahr. to 78.6 deg. fahr. on the thermometer scale, whereas the correction necessary from 29 in. Hg to 25 in. Hg barometer is equivalent to a change to a temperature of (29 × 520) 25 or 603.2 deg. fahr. absolute (143.2 deg. fahr.) with the barometer remaining at 29 in. Hg. The distance on the barometer scale from 29 in. to 25 in. must therefore equal the distance from 60 deg. fahr. to 143.2 deg. fahr.

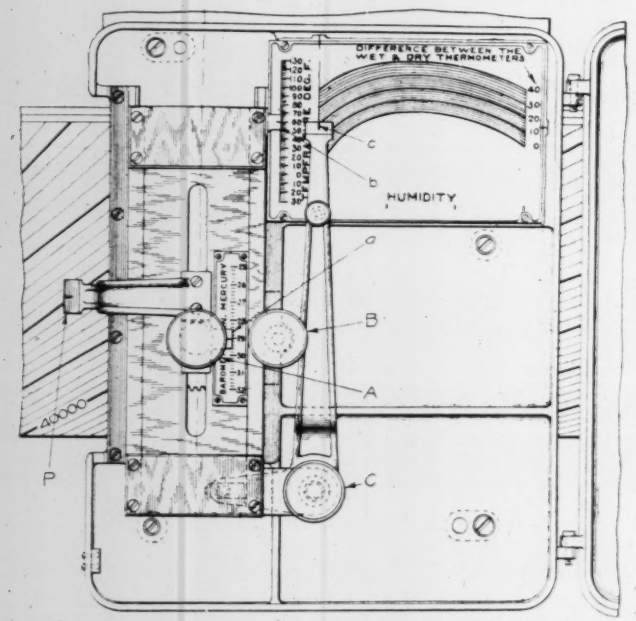


FIG. 9 VIEW OF VOLUME CORRECTOR SHOWING DETAILS

The barometric scale constructed on the above principle for the volume corrector is evidently a reverse and reciprocal (that is, non-uniform) scale. For constructional reasons, and chiefly to take care of humidity corrections explained later, it is desirable to have this scale uniform without affecting in any way the accuracy of the instrument. This is accomplished in the following manner:

Referring to Fig. 11, which gives a view of the volume corrector shown in Fig. 9 but with some of the front cover plate removed, *A*, *B* and *C* are the pins to which the milled heads *A*, *B* and *C* of Fig. 9 are attached. The main pointer in Fig. 9 is moved up and down in a vertical slot by means of pin *p* in Fig. 11. When the operator moves milled head *A* so that pointer *a* indicates the barometer reading, gearwheel *D* (Fig. 11) rotates about pin *A* because it is meshed into a rack *E* which remains stationary. Motion is given to pin *p* (which is held in a vertical slot) by the slot *S* in gearwheel *D*. This slot is in the form of a cam and so designed that pin *p*, and therefore the main pointer *P*, moves the proper distance vertically. The main pointer will move a less distance vertically when barometer pointer moves from 32 in. to 31 in. than it will when moving from 31 in. to 30 in., and less from 31 in. to 30 in. than it will from 30 in. to 29 in. Therefore, although the barometer scale over which pointer *A* moves has uniform divisions, the actual vertical distance through which the main pointer *P* moves is non-uniform and follows a reciprocal scale.

The setting of temperature is accomplished through milled head *B* which is attached to a plate movable vertically between

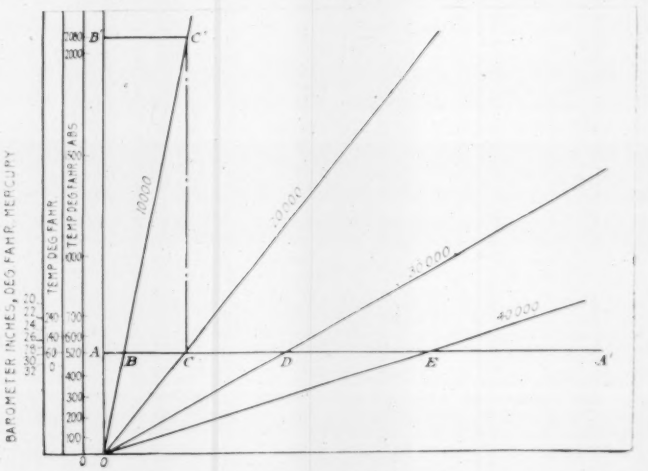


FIG. 10 DIAGRAM ILLUSTRATING CONSTRUCTION OF SCALES ON VOLUME CORRECTOR

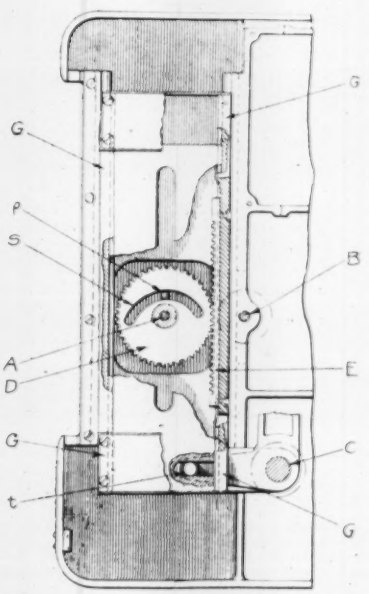


FIG. 11 SECTIONAL VIEW OF VOLUME CORRECTOR

gibs *GG* and which carries with it the rack *E*, gearwheel *D*, and pin *p* with main pointer *P*. Moving *B* up and down does not revolve gearwheel *D* at all (that is, does not disturb the barometer setting), but simply moves main pointer *P* over a temperature scale shown in Fig. 9. Pointer *b* is set opposite the proper temperature reading.

The corrections for humidity in the volume corrector are based upon the following considerations: The barometric-pressure reading as usually observed is equal to the sum of the air pressure plus the vapor pressure. If the air is

saturated, that is, if it contains all the water vapor it is capable of holding without precipitation at the particular temperature, the value of the vapor pressure at the given temperature can be ascertained experimentally or taken from the steam tables. If the degree of saturation or the relative humidity is, say, only 20 per cent or 50 per cent, then the vapor pressure as determined experimentally must be multiplied by 0.20 or 0.50 as the case may be.

The most usual method of ascertaining the relative humidity of the air is by means of a wet- and dry-bulb thermometer arrangement. In its simplest form it consists of two similar thermometers, the bulb of one of which is covered by a wet piece of sponge. If the air is fully saturated no evaporation into it can take place and the two thermometers record the same temperature. When the air is only partly saturated, the evaporation from the wet bulb lowers the thermometer reading; so that the difference in the readings of the wet and dry thermometers can be taken as a measure of the relative humidity of the air. For any combination of relative humidity and atmospheric temperature the vapor pressure is a definite quantity. This vapor pressure must be subtracted from the observed barometer reading in order to give the net or correct air pressure to be used on the barometer scale above described; since it is the density (and therefore the actual pressure) of the air alone that is of importance, and not the density of the mixture of air and water vapor.

It is important to note that the humidity correction in pounds per square inch or in inches of mercury is independent of the actual barometer reading, and depends only on the atmospheric temperature and on the difference between the wet- and dry-bulb thermometer readings (relative humidity). The humidity correction can therefore be made mechanically if the pointer P on the sliding weight is given an additional correction or movement which would be the equivalent amount of a certain subtraction of pressure on the barometric scale equal to the correction for the pressure due to vapor. It is for this reason that it is preferable to make the divisions on the barometric scale uniform, so that, for instance, a half-inch mercury correction would require the same movement no matter at what reading the barometer scale happened to be set. As will be shown later, the volume corrector accomplishes this; therefore, no matter where the barometer pointer a is set, the humidity correction moves the main pointer P on the sliding weight the proper amount. It will also be noticed that the humidity is a function of the atmospheric temperature, that is, when the temperature is high the water vapor in the saturated air is higher than when the temperature is low. In the volume corrector the setting of the temperature pointer b on the temperature scale automatically sets the humidity pointer c to the correct temperature also.

Referring to Fig. 9, the correction for humidity is made by loosening milled head C and swinging pointer c until it intersects or indicates the proper amount of difference in reading between the wet- and dry-bulb thermometer. The movement of the long arm carrying pointer c about the center of milled head C moves pin t attached to a plate carrying gearwheel D, but does not move rack E. Moving gearwheel D vertically up or down rotates D because E is stationary and thereby moves the main pointer P similarly, as heretofore described.

ACCURATE CONSTANT-VOLUME GOVERNING

The volume corrector therefore is an instrument which can be set by an operator at the existing barometer, temperature and humidity of the atmospheric air and when so set will permit the setting of the sliding weight on the scale beam in a position so that the constant-volume governor will hold or deliver the correct volume of air which would contain the same weight of oxygen as would be contained in a certain predetermined and desired volume of standard air.

This means that the blast-furnace operator, knowing the chemical compositions of the coke and iron ore and the amounts charged to the furnace in a stated period of time, can determine the exact volume of standard air (dry, 60 deg. fahr., 29 in. Hg) which will contain the proper amount of oxygen necessary for combustion of the coke and reduction of the iron ore in the blast furnace. He need not perform any mathematical calculations as to how much more or how much less air must be supplied when the atmospheric conditions are not those considered standard in order to be sure the blast furnace is receiving at all times its exact and necessary weight of oxygen.

The volume corrector needs resetting every time the operator notices any change in the barometer, temperature or difference between the wet- and dry-bulb thermometer reading in order to be sure of securing the most efficient regulation. The air conditions, however, do not vary rapidly and the practice of inserting in an engine-room log every half hour the steam pressure, r.p.m., vacuum and other information can easily be extended to include readings of the barometer and wet- and dry-bulb instrument. Even with the front cover of the volume corrector closed, transparent places are provided which will permit any one checking or observing these settings. The need of a volume corrector is apparent from the fact that it is possible to have a variation of weight of oxygen delivered to a furnace of 5 to 10 per cent ordinarily and in extreme cases as high as 20 per cent as a result of variations in atmospheric-air conditions, especially as between winter and summer. The gains in quality and quantity of output of a blast furnace obtained even by the former methods of constant-volume governing without volume corrections will be still further improved by the use of constant-volume governing with proper volume corrections.

As a result of representations received from the Advisory Council of the Committee of the Privy Council for Scientific and Industrial Research, and of public meetings held in Glasgow, a joint committee of the Institution of Engineers and Shipbuilders in Scotland, and the West of Scotland Iron and Steel Institute, have prepared a draft memorandum outlining the proposed constitution for a Scottish Engineering, Shipbuilding, and Metallurgical Research Association. The draft memorandum proposes that the objects of the new association should include the following: (1) To promote research and other scientific work in connection with the trades and industries included within the scope of the association; (2) to apply for and accept grants from the Government for the purposes of the association; (3) to establish, form and maintain museums, collections, libraries, etc., and to translate, compile, collect, publish, lend, sell any literature, statistics and information in connection with the trades or industries concerned; (4) to encourage discoveries and inventions in connection with these trades or industries; (5) to establish, promote, coöperate with, receive into union or combine with any other bodies, or persons engaged or interested in similar research work, either in Scotland or elsewhere; and all such subsidiary powers as may be necessary for carrying out the objects of the Association.

REVISION OF BOILER CODE

THE Council of the Society directed that a hearing be conducted in accordance with the recommendation in the Boiler Code that a meeting at which all interested parties may be heard be held at least once in two years to make such revisions as may be found desirable in the Code and to modify the Code as the state of the art advances. The first of these meetings was held at the Society's headquarters in New York, December 8 and 9, 1916.

The Council also directed that the proposed revisions in the Boiler Code be published in THE JOURNAL with the request that they be fully and freely discussed, so as to make it possible for any one to suggest changes before the Rules are brought to the final form and presented to the Council for approval. This has been done, and the revisions are presented below in the form finally proposed for submission to the Council, except as they may be modified by editing without change of sense. Discussions should be mailed to Mr. C. W. Obert, Secretary of the Boiler Code Committee, 29 West 39th Street, New York, N. Y., and they will be presented and acted on by the Boiler Code Committee.

PAGE 1

TITLE PAGE

Change line at bottom of p. 1 which reads as follows:

Edition of 1914 with Index

to read as follows:

Edition of 1918

(New edition of Boiler Code to be copyrighted under date of 1918).

PAGE 2

LETTER TO THE COUNCIL

Change letter to the Council to read as follows:

To the Council of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

GENTLEMEN: Your Committee respectfully submits the following revised report on Rules for the construction of, and allowable working pressures on stationary boilers, this report forming a part of the task that has been assigned to it. Stationary boilers as here considered are land boilers and include portable and traction boilers. The Rules do not apply to boilers which are subject to federal inspection and control, such as marine boilers, boilers of steam locomotives and other self-propelled railroad apparatus.

The primary object of the Rules is to secure safe boilers. The interests of boiler users and manufacturers have been carefully considered and the requirements made such that they will not entail undue hardship by departing too widely from present practice.

The Code applies only in part to certain special forms of boilers such as those of the forced circulation or flash type. New matter has been added to state that the material for boilers of this class shall conform to the requirements of the Code, and that other requirements shall also be met except where they relate to special features of construction made necessary in boilers of this type, and to accessories that are manifestly not needed or used in connection with such boilers, such as water gages, water columns, and gage cocks.

In those states and municipalities which have adopted the Boiler Code, your Committee recommends that all requests for interpretations of the Boiler Code be referred to the state authorities having jurisdiction over such matters. In order to maintain uniformity of practice it is also suggested that the authorities having jurisdiction be requested to submit all inquiries where there is any question of doubt to the Boiler Code Committee. Where there is a question respecting the interpretation of the Code, or where constructions apparently are not covered by the Code, it will be most desirable to have the matter referred to the Boiler Code Committee. Unless this procedure is followed, the aim to obtain uniformity in the application of the Code will be defeated. The Boiler Code Committee desires to cooperate to the limit of its ability in assisting in the application of the Code, and will take pleasure in considering all matters where there is any question of doubt that may be brought before it by the various states and municipalities that adopt the Code.

The Committee does not pass on questions concerning specific designs of boilers or appurtenances thereto.

The specifications given in the Code are the same as or similar to those of the American Society for Testing Materials. The Specifications for Boiler Plate Steel published in the Code (Edition of 1914) were approved and recommended in their modified form, October 9, 1914, by The Association of American Steel Manufacturers, the American Boiler Manufacturers' Association, the National Tubular Boiler Manufacturers' Association, the National Association of Thresher Manufacturers and the representatives present of leading Water Tube Boiler Manufacturers, with whom the Boiler Code Committee was in conference on September 16, 1914, and by whom further modifications were afterwards offered.

The Specifications for Lapwelded and Seamless Boiler Tubes were approved by the Boiler Tube Manufacturers of America, September 25, 1914. Changes made in the specifications published in the original Code have been considered by sub-committees of the American Society for Testing Materials, of The Association of American Steel Manufacturers, and of the Boiler Code Committee in order that cooperation might be secured through these sub-committees making joint recommendations to their respective organizations.

Your Committee recommends that a hearing be held by the Boiler Code Committee at least once in four years at which all interested parties may be heard, in order that such revisions may be made as are found to be desirable, as the state of the art advances.

Yours truly,

JOHN A. STEVENS, *Chairman.*

Wm. H. Boehm, Boiler Insurance
Rolla C. Carpenter, Engineering Research
Frank H. Clark, Railroad Sub-Committee, THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
Francis W. Dean, Consulting Engineers
Thomas E. Durban, Chairman, The American Uniform Boiler Law Society. All types of boilers
E. R. Fish, American Boiler Manufacturers Association
Elbert C. Fisher, Scotch marine and other types of boilers
Charles E. Gorton, Steel heating boilers
Arthur M. Greene, Jr., Engineering Education
Richard Hammond, Scotch marine and other types of boilers
A. L. Humphrey, Railroad Sub-Committee, THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
Charles L. Huston, Boiler plate manufacturer
D. S. Jacobus, Water-tube boilers
S. F. Jeter, Boiler Insurance
Wm. F. Kiesel, Jr., Railroad Sub-Committee, THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
F. R. Low, Technical Press
W. F. MacGregor, National Association of Tractor and Thresher Manufacturers
Edward F. Miller, Engineering Research

Submitted to the Council of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, ... (date) .....

M. F. Moore, Steel heating boilers
I. E. Moultrop, Boiler users
Richard D. Reed, Cast-iron heating boilers.
H. H. Vaughan, Railroad Sub-Committee, THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
C. W. Obert, Secretary to Committee.

PAGE 5

HEADING

Insert above heading of p. 5 the following:

A.S.M.E. Boiler Code

PAGE 7

HEADING

Insert above heading of p. 7 the following:

A.S.M.E. Boiler Code

PAGE 8

PAR. 9. MAKE THE FOLLOWING CHANGE IN PAR. 9:

In second line, omit "and" after the word "headers" and insert a comma.

ALSO ADD A SENTENCE AS FOLLOWS:

Malleable iron may be also used when the maximum allowable working pressure does not exceed 200 lb. per sq. in., and the form and size of the internal cross-section, perpendicular to the longest dimension of the box, shall be such that it will fall within a 7 in. by 7 in. rectangle.

PAR. 12. CHANGE PAR. 12 TO READ AS FOLLOWS:

12 Cast iron shall not be used for nozzles or flanges attached directly to the boiler at any pressure or temperature, nor for boiler and superheater mountings such as connecting pipes, fittings, valves and their bonnets, for steam temperatures of over 450 deg. fahr.

PAR. 13. CHANGE PAR. 13 TO READ AS FOLLOWS:

13 Water-leg and door-frame rings of vertical fire-tube boilers, and of locomotive and other type boilers, shall be of wrought iron or steel, or cast steel of Class *A* or Class B grade, as designated in the Specifications for Steel Castings. The O.G. or other flanged construction may be used as a substitute in any case.

PAR. 14. INSERT THE FOLLOWING AT THE BEGINNING OF PAR. 14:

In determining the maximum allowable working pressure,

PAGE 9

PAR. 19. CHANGE PAR. 19 TO READ AS FOLLOWS:

19 The minimum thickness of butt straps shall be as given in Table 1. Intermediate values shall be determined by interpolation. For plate thicknesses exceeding $1\frac{1}{4}$ in., the thickness of the butt straps shall be not less than two-thirds of the thickness of the plate.

TABLE 1. CHANGE VALUE FOR MINIMUM THICKNESS OF BUTT STRAPS FOR 1 IN. THICKNESS OF SHELL PLATES FROM $\frac{3}{4}$ IN. TO $1\frac{1}{4}$ IN.

PAGE 10

PAR. 21. MODIFICATION OF THIS PARAGRAPH IS IN THE HANDS OF A SPECIAL SUB-COMMITTEE OF THE BOILER CODE COMMITTEE ON TUBE SIZES.

PAGE 11

OMIT SUBHEADING UNDER CAPTION: SPECIFICATIONS FOR BOILER PLATE STEEL. ALSO OMIT 7-LINE FOOTNOTE AT BOTTOM OF PAGE.

PAR. 25. MAKE THE FOLLOWING CHANGE IN THE TABLE:

Omit last line of Table which reads as follows:

"Copper ..... Not over 0.05 per cent."

PAGE 12

PAR. 29. MAKE THE FOLLOWING CHANGES IN PAR. 29:

29 *Modifications in Elongation.* *a* For material over $\frac{5}{16}$ in. in thickness, a deduction shall be made from the percentage of elongation in Par. 28*a* of four times the thickness in inches in excess of $\frac{5}{16}$ in. to a minimum of 20 per cent.

b Strike out the words "or under" from the first line.

PAR. 30. CHANGE PAR. 30 TO READ AS FOLLOWS:

30*a* *Test Specimens.* Tension test specimens shall be taken longitudinally from the bottom of the finished rolled material, and bend test specimens shall be taken transversely from the middle of the top of the finished rolled material. The longitudinal test specimen shall be taken in the direction of the longitudinal axis of the ingot, and the transverse test specimen at right angles to that axis.

b *Bend Test.* The bend test specimen shall bend cold through 180 deg. without cracking on the outside of the bent portion, as follows: For material 1 in. or under in thickness, around a pin the diameter of which is equal to the thickness of the specimen; and for material over 1 in. in thickness, around a pin the diameter of which is equal to twice the thickness of the specimen.

PAR. 31. CHANGE FIRST SECTION OF PAR. 31 TO READ AS FOLLOWS:

31 *Homogeneity Tests.* Homogeneity tests shall be made for fire-box steel on both the broken tension test specimen taken from the lower part of the plate, and on the bend test specimen taken transversely from the middle of the top of the plate. The tests made on the broken tension test specimen shall not show any single seam or cavity more than one-quarter inch long in either of the three fractures obtained in a test of homogeneity, which shall be made as follows:

INSERT A FOOT-NOTE TO READ AS FOLLOWS:

The requirements for the homogeneity tests of the bend test specimen taken transversely from the middle of the top of the plate will be determined by tests, and until such requirements are agreed on by the Boiler Code Committee and published by the A.S.M.E., no homogeneity tests need be made on material taken from the middle of the top of the plate.

PAGE 13

PAR. 33*a*. CHANGE PAR. 33*a* TO READ AS FOLLOWS:

33 *Number of Tests.* *a* One tension and one bend test shall be made from each plate as rolled.

PAGE 15

OMIT SUB-HEADING UNDER CAPTION: SPECIFICATIONS FOR BOILER RIVET STEEL.

PAGE 19

OMIT SUB-HEADING UNDER CAPTION: SPECIFICATIONS FOR STEEL BARS.

PAGE 22

OMIT SUB-HEADING UNDER CAPTION: SPECIFICATIONS FOR STEEL CASTINGS

[1] Exceptions are made for tension test specimens for plate which is rolled longitudinally with reference to position when used in a boiler shell; see Par. 190.

PAGE 26

OMIT SUB-HEADING UNDER CAPTION: SPECIFICATIONS FOR GRAY IRON CASTINGS

PAGE 29

OMIT SUB-HEADING UNDER CAPTION: SPECIFICATIONS FOR MALLEABLE CASTINGS

PAGE 31

OMIT SUB-HEADING UNDER CAPTION: SPECIFICATIONS FOR BOILER RIVET IRON

PAR. 123. MAKE THE FOLLOWING CHANGE IN PAR. 123*a*:

Change the percentage of yield point from 0.6 tensile strength to read 0.5 tens. str.

PAGE 34

OMIT SUB-HEADING UNDER CAPTION: SPECIFICATIONS FOR STAYBOLT IRON

PAR. 141. MAKE THE FOLLOWING CHANGE IN PAR. 141:

Change the percentage of yield point from 0.6 tensile strength to read 0.5 tens. str.

PAGE 37

OMIT SUB-HEADING UNDER CAPTION: SPECIFICATIONS FOR REFINED WROUGHT IRON BARS

PAGE 40

OMIT SUB-HEADING UNDER CAPTION: SPECIFICATIONS FOR LAPWELDED AND SEAMLESS BOILER TUBES

PAR. 164. MAKE THE FOLLOWING CHANGE IN PAR. 164*a*:

In the second line, insert a comma after the word "knobbled."

PAR. 167*a*. CHANGE PAR. 167*a* TO READ AS FOLLOWS:

167 *Flange Test.* *a* For tubes not more than 6 in. diameter a test specimen not less than 4 in. in length shall have a flange turned over at right angles to the body of the tube without cracking or showing any flaw. This flange as measured from the outside of the tube shall have a width of from $\frac{1}{8}$ in. to $\frac{1}{2}$ in., the width between these limits to be not less than 10 per cent of the outside diamter of the tube. For tubes more than 6 in. diameter the flange test is not required.

PAGE 41

PAR. 169. CHANGE PAR. 169 TO READ AS FOLLOWS:

169 *Hydrostatic Tests.* Tubes under 5 in. in diameter shall stand an internal hydrostatic pressure of 1000 lb. per sq. in. and tubes 5 in. in diameter or over, an internal hydrostatic pressure of 800 lb. per sq. in., provided that the fibre stress does not exceed 16,000 lb. per sq. in., in which case the test pressure shall be determined by the following formula:

$$P = \frac{32{,}000}{D} \times t$$

where t is the wall thickness in inches; D is the inside diameter in inches. Lapwelded tubes shall be struck near both ends, while under the test pressure, with a 2 lb. steel hand hammer, the blow to be equivalent to 2 lb. falling 2 ft.

PAGE 42

PAR. 174. CHANGE PAR. 174 TO READ AS FOLLOWS:

174 *Workmanship.* Finished tubes $3\frac{1}{2}$ in. or under in outside diameter shall be circular within 0.02 in. and the mean outside diameter shall not vary more than 0.015 in. from the size ordered. For tubes over $3\frac{1}{2}$ in. in outside diameter, these variations shall not exceed 0.5 per cent of the outside diameter. All tubes shall be carefully gaged with a B.W.G. gage and shall not be less than the gage specified. Tubes on which the standard slot gage, specified, will go on tightly at the thinnest point, will be accepted. The length shall not be less, but may be 0.125 in. more than that ordered.

PAR. 176. CHANGE PAR. 176 TO READ AS FOLLOWS:

176 *Marking.* The name or brand of the manufacturer, the material from which it is made, and the pressure in lb. per sq. in. at which it was tested, shall be legibly stenciled on each tube.

PAGE 44

PAR. 182. MODIFICATION OF THIS PARAGRAPH IS IN THE HANDS OF A SPECIAL SUB-COMMITTEE OF THE BOILER CODE COMMITTEE OF BACK PITCH

PAR. 183. ADD THE FOLLOWING WORDS TO THE END OF PAR. 183:

this distance to be measured from the centers of the rivet holes to the nearest edge.

PAR. 184. CHANGE PAR. 184 TO READ AS FOLLOWS:

184 *Circumferential Joints.* *a* The strength of circumferential joints of boilers, the heads of which are not stayed by tubes or through braces, shall be at least 50 per cent of that required for the longitudinal joints of the same structure.

b When 50 per cent or more of the load which would act on an unstayed solid head of the same diameter as the shell, is relieved by the effect of tubes or through stays, in consequence of the reduction of the area acted on by the pressure and the holding power of the tubes and stays, the strength of the circumferential joints in the shell shall be at least 35 per cent of that required for the longitudinal joints.

c In circumferential joints of horizontal return tubular boilers the shearing strength of the rivets shall be not less than 50 per cent of the full strength of the plate corresponding to the thickness at the joint.

PAGE 45

PAR. 186. CHANGE PAR. 186 TO READ AS FOLLOWS:

186 *Welded Joints.* The ultimate strength of a joint which has been properly welded by the forging process, shall be taken as 28,500 lb. per sq. in., with steel plates having a range in tensile strength of 47,000 to 55,000 lb. per sq. in. Autogenous welding may be used in boilers in cases where the strain is carried by other construction which conforms to the requirements of the Code and where the safety of the structure is not dependent upon the strength of the weld. Autogenous welding shall not be used in place of calking on girth joints.

PAR. 187. CHANGE PAR. 187 TO READ AS FOLLOWS:

187 *Riveted Longitudinal Joints.* The riveted longitudinal joints of a shell or drum which exceeds 36 in. in diameter, shall be of butt and double-strap construction. This rule does not apply to the portion of a boiler shell which is staybolted to the firebox sheet.

PAR. 190. CHANGE PAR. 190 TO READ AS FOLLOWS:

190 In horizontal return tubular boilers with lap joints no course shall be over 12 ft. long. With butt and double strap construction longitudinal joints of any length may be used, provided the tension test specimens are so cut from the plate that their lengthwise direction is parallel with circumferential seams of the boiler and the tests meet the standards prescribed in the specifications for boiler plate steel.

PAGE 46

PAR. 192. ADD NEW SECTION TO PAR. 192 AS FOLLOWS:

c The strength of those ligaments between the tube holes which are subjected to a longitudinal stress shall be at least one-half the required strength of those ligaments which come between the tube holes which are subjected to a circumferential stress.

PAGE 47

PAR. 193. MODIFICATION OF THIS PARAGRAPH IS IN THE HANDS OF A SPECIAL SUB-COMMITTEE OF THE BOILER CODE COMMITTEE ON DIAGONAL LIGAMENTS

PAGE 48

PAR. 194. REPLACE THE FIRST SECTION OF PAR. 194 BY THE FOLLOWING:

194 *Domes.* The longitudinal joint of a dome 24 in. or over in diameter shall be of butt and double-strap construction irrespective of pressure. When the maximum allowable working pressure exceeds 100 lb. per sq. in., the flange of a dome 24 in. or over in diameter shall be double riveted to the boiler shell.

PAGE 49

PAR. 195. ADD AFTER NOTATION FOLLOWING FORMULA:

Where two radii are used the longer shall be taken as the value of *L* in the formula.

CHANGE THE LAST SENTENCE OF THIS PARAGRAPH TO READ AS FOLLOWS:

When a dished head has a manhole opening, the thickness as found by these Rules shall be increased by not less than $\frac{1}{8}$ in. over that called for by the formula.

PAR. 198. CHANGE PAR. 198 TO READ AS FOLLOWS:

198 A manhole opening in a dished head shall be flanged to a depth of not less than three times the *required* thickness of the head measured from the outside.

PAGE 50

PAR. 199. ADD TO THE LIST OF VALUES OF *C* THE FOLLOWING:

C = 150 for stays screwed through plates or made a taper fit and having the heads formed on the stays before installing them and not riveted over, said heads being made to have a true bearing on the plate and the diameter of the heads being not less than 1.3 times the diameter of the stays.

REVISE MATTER FOLLOWING LIST OF VALUES OF *C* TO MAKE IT READ AS FOLLOWS:

If flat boiler plates not less than $\frac{3}{8}$ in. thick are strengthened with doubling plates securely riveted thereto and having a thickness of not less than $\frac{2}{3}$ *t*, then the value of *t* in the formula shall be three-quarters of the combined thickness of the boiler plate and doubling plates but not more than one and one-half times the thickness of the boiler plate, and the values of *C* given above may also be increased 15 per cent.

When two sheets are connected by stays and but one of these sheets requires staying, the value of *C* is governed by the thickness of the sheet requiring staying. Acceptable proportions for the ends of through stays are indicated in Fig. 12a.

PAR. 200. CHANGE PAR. 200 TO MAKE IT READ AS FOLLOWS:

200 *Staybolts.* The ends of screwed staybolts shall be riveted over or upset by equivalent process. The outside ends of solid staybolts, 8 in. and less in length, shall be drilled with a hole at least 3-16 in. diameter to a depth extending at least $\frac{1}{2}$ in. beyond the inside of the plates, or hollow staybolts may be used. On boilers having a grate area not exceeding 15 sq. ft., or the equivalent in gas or oil fired boilers, the drilling or staybolts is optional. Solid staybolts over 8 in. long, and flexible staybolts of either the jointed or ball and socket type, need not be drilled. Staybolts used in waterlegs of water-tube boilers shall be hollow or drilled at both ends, irrespective of their length.

PAR. 201. INSERT THE FOLLOWING SIDEHEAD IN THE FIRST LINE:

Structural Reinforcements.

ADD TO PAR. 201 THE FOLLOWING:

If the outstanding legs of the two members are fastened together so that they act as one member in resisting the bending action produced by the load on the rivets attaching the members to the head of the boiler, and provided that the spacing of these rivets attaching the members to the head is approximately uniform, the members may be computed as a single beam uniformly loaded and supported at the points where the through braces are attached.

PAGE 51

PAR. 202. INSERT THE FOLLOWING SIDEHEAD IN THE FIRST LINE:

Stays.

PAR. 203. CHANGE PAR. 203 TO READ AS FOLLOWS:

203*a* The maximum spacing between centers of rivets or between the edges of tube holes and the centers of rivets attaching the crowfeet of braces to the braced surface, shall be determined by the formula in Par. 199, using 135 for the value of *C*.

b The maximum distance between the edges of tube holes and the centers of other types of stays shall be determined by the formula in Par. 199, using the value of *C* given in Par. 199 which applies to the thickness of plate and type of stay used.

c The maximum spacing between the inner surface of the shell and lines parallel to the surface of the shell passing through the centers of the rivets attaching the crowfeet of braces to the head, shall be determined by the formula in Par. 199, using 175 for the value of *C*.

d The maximum distance between the inner surface of the shell and the centers of braces of other types shall be determined by the formula in Par. 199, using a value of *C* equal to 1.3 times that value of *C* in Par. 199 which applies to the thickness of plate and type of stay as therein specified.

e In applying these rules and those in Par. 199 to a head or plate having a manhole or reinforced opening, the spacing applies only to the plate around the opening and not across the opening.

UNDER TABLE 3 INSERT:

For the application of Pars. 205, 206 and 207, see Appendix (Par. . . .) (illustrations in Fig. 31). .

PAR. 212. CHANGE PAR. 212 TO READ AS FOLLOWS:

212*a* The maximum allowable working pressure for any curved stayed surface subject to internal pressure shall be obtained by the two following methods, and the minimum value obtained shall be used:

First, the maximum allowable working pressure shall be computed without allowing for the holding power of the stays, due allowance being made for the weakening effect of the holes for the stays. To this pressure there shall be added the pressure secured by the formula for braced and stayed surfaces given in Par. 199 using 70 for the value of *C*.

Second, the maximum allowable working pressure shall be computed without allowing for the holding power of the stays, due allowance being made for the weakening effect of the hole for the stay. To this pressure there shall be added the pressure corresponding to the strength of the stays for the stresses given in Table 4, each stay being assumed to resist the steam pressure acting on the full area of the external surface supported by the stay.

b The maximum allowable working pressure for a stayed wrapper sheet of a locomotive type boiler shall be determined by the first method given above and by the method which follows and the minimum value obtained shall be used:

$$P = \frac{11{,}000t \times E}{R - s\Sigma \sin \alpha}$$

in which

α = Angle any crown stay makes with vertical axis of boiler

$\Sigma \sin \alpha$ = Summated value of α for all crown stays considered in one transverse plane and on one side of vertical axis of boiler

s = Transverse spacing (in.) of crown stays in crown sheet

E = Minimum efficiency of wrapper sheet through joints or stay holes

t = Required thickness of wrapper sheet (in.)

R = Radius of wrapper sheet (in.)

P = Working pressure of boiler, lb. per sq. in.

11,000 = Allowable stress, lb. per sq. in.

c An internal cylindrical furnace which requires staying shall be stayed as a flat surface as indicated in Table 3, except that the pitch may be increased to p_1 as provided in the following formula:

$$p_1 = p \sqrt{\frac{P_t}{Pt - 2.08t}}$$

in which p, P, R, and t are the same as in Par. 199.

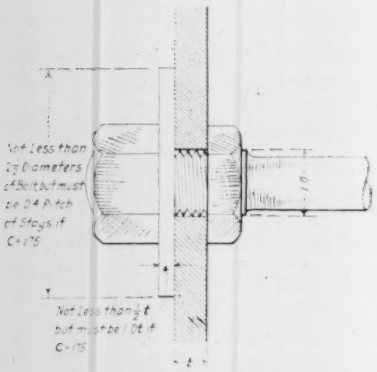


FIG. 12A ACCEPTABLE PROPORTIONS FOR ENDS OF THROUGH STAYS

PAR. 214. CHANGE PAR. 214 TO MAKE IT READ AS FOLLOWS:

214 *Areas of Segments of Heads to be stayed.* The area of a segment of a head to be stayed shall be the area enclosed by lines drawn 2 in. from the tubes and a distance d from the shell as shown in Figs. 13 and 14. The value of d used shall be the larger of the following values but not less than 3 in.

(1) d = the outer radius of the flange, not exceeding 8 times the thickness of the head

(2) $d = \frac{5 \times t}{\sqrt{P}}$

Where d = unstayed distance from shell in inches
t = thickness of head in sixteenths of an inch
P = maximum allowable working pressure in lb. per sq. in.

(NOTE. DIMENSIONS IN FIGS. 13 AND 14 NOW MARKED 3" TO BE CHANGED TO d).

PAR. 215. CHANGE PAR. 215 TO MAKE IT READ AS FOLLOWS:

215 When the heads of drums of water tube boilers are 30 in. or less in diameter and the tube plate is stiffened by flanged ribs or gussets, no stays need be used if a hydrostatic test to destruction of a boiler or unit section built in accordance with the construction, shows that the factor of safety is at least five.

PAR. 216. CHANGE PAR. 216 TO READ AS FOLLOWS:

216 Stays shall be used in the tube sheets of a fire-tube boiler if the distance between the edges of the tube holes exceeds the maximum pitch of staybolts for the corresponding plate thickness and pressure given in Table 3. That part of the tube sheet which comes between the tubes and the shell need not be stayed, if the nearest tangent common to two tube holes when measured on any radius of the tube sheet that intersects the tangent between the holes, does not exceed this maximum pitch by more than 3 in. The tube holes to which a common tangent may be drawn in applying this rule shall not be at a greater distance from edge to edge than the maximum pitch referred to.

PAGE 54

PAR. 218. INSERT IN FOURTH LINE BEFORE WORD "THICKNESS," THE WORD "REQUIRED."

ADD TO PAR. 218 THE FOLLOWING:

The distance in the clear between the bodies of the braces, or of the inside braces where more than two are used, shall not be less than 10 in. at any point.

PAR. 220. CHANGE PAR. 220 TO READ AS FOLLOWS:

220*a* The full pitch dimensions of the stays shall be employed in determining the area to be supported by a stay, and the area occupied by the stay, shall be deducted therefrom to obtain the net area. The product of the net area in square inches by the maximum allowable working pressure in lb. per sq. in., gives the load to be supported by the stay.

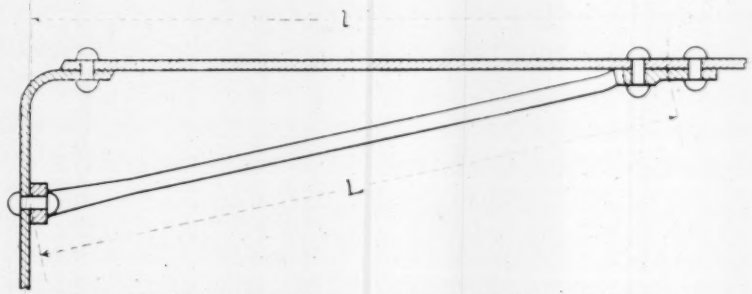


FIG. 15 MEASUREMENTS FOR DETERMINING STRESSES IN DIAGONAL STAYS

b Where stays come near bounding surfaces and special allowances are made for the spacing, the load to be carried by such stays shall be determined by neglecting the added area provided for by these special allowances. For example, if the minimum pitch by Table 3 would make a staybolt come 6 in. from the edge of the plate and a special allowance would make it come 7 in., the distance of 6 in. should be used in computing the load to be carried.

TABLE 4 MAXIMUM ALLOWABLE STRESSES FOR STAYS AND STAYBOLTS

	Description of Stays	Stresses lb. per sq. in. For lengths between supports not exceeding 120 diameters	Stresses lb. per sq. in. For lengths between supports exceeding 120 diameters
a	Unwelded or flexible stays less than twenty diameters long screwed through plates with ends riveted over	7,500	.....
b	Hollow steel stays less than 20 diameters long, screwed through plates with ends riveted over	.....	.....
c	Unwelded stays and unwelded portions of welded stays, except as specified in line *a* and line *c*	9,500	8,500
d	Steel through stays exceeding 1½ in. diameter	10,400	9,000
e	Welded portions of stays	6,000	6,000

c The maximum allowable stress per square inch at point of least net cross-sectional area of stays and staybolts shall be given in Table 4. In determining the net cross-sectional area of drilled or hollow staybolts, the cross-sectional area of the hole shall be deducted.

d The length of the stay between supports shall be measured from the inner faces of the stayed plates. The stresses are based on tension only. For computing stresses in diagonal stays, see Pars. 221 and 222.

TABLE 4. ADD TO TABLE 4 SO THAT IT WILL READ AS ABOVE:

PAGE 55

PAR. 221. REPLACE FIG. 15 BY REVISED CUT.

PAR. 223. CHANGE PAR. 223 TO READ AS FOLLOWS:

223 *Design of Braces and Brace Connections.* All rivet and pin holes shall conform to the requirements in Par. 253 and the pins shall be made a neat fit. To determine the sizes that shall be used proceed as follows:

1. Determine the "required cross-sectional area of the brace" by first computing the total load to be carried by the brace, and dividing the total load by the value of allowable stress for unwelded stays given in Table 4.

2. Design the body of the brace so that the cross-sectional area shall be at least equal to the "required cross-sectional area of the brace" for unwelded braces. Where the braces are welded, the cross-sectional area at the weld shall be at least as great as that computed for a stress of 6000 lb. per sq. in. (see Table 4).

3. Make the area of pins to resist double shear at least three-quarters of the "required cross-sectional area of the brace."

4. Make the combined cross-section of the eye at the side of the pin (in crowfoot braces) at least 25 per cent greater than the "required cross-sectional area of the brace."

5. Make the cross-sectional areas through the blades of diagonal braces where attached to the shell of the boiler at least equal to the required rivet section; that is, at least equal to one and one-quarter times the "required cross-sectional area of the brace."

6. Design each branch of a crowfoot to carry two-thirds the total load on the brace.

7. Make the net sectional areas through the sides of the crowfoot, tee irons, or similar fastenings at the rivet holes at least equal to the required rivet section, that is, at least equal to one and one-quarter times the "required cross-sectional area of the brace."

8. Make the combined cross-sectional area of the rivets at each end of the brace at least one and one-quarter times the "required cross-sectional area of the brace."

PAGE 58

PAR. 231. CHANGE PAR. 231 TO MAKE IT READ AS FOLLOWS:

231 *Maximum Allowable Working Pressure on Truncated Cones.* *a.* Upper combustion chambers of vertical submerged tubular boilers made in the shape of a frustum of a cone, when not over 38 in. diameter at the large end, may be used without stays if computed by the rule for plain cylindrical furnaces (Par. 239) making D in the formula equal to the diameter at the large end; provided that the longitudinal joint conforms to the requirements of Par. 239.

b. When over 38 in. in diameter at the large end, that portion which is over 30 in. in diameter shall be fully supported by staybolts or gussets to conform to the provisions for staying flat surfaces. In this case the top row of staybolts shall be at a point where the cone top is 30 in. or less in diameter.

In calculating the pressure permissible on the unstayed portion of the cone, the vertical distance between the horizontal planes passing through the centers of the rivets at the cone top, and through the center of the top row of staybolts shall be used as L in Par. 239, and D in that paragraph shall be the inside diameter at the center of the top row of staybolts.

PAGE 60

PAR. 234. UNDER "WHERE" CHANGE DERIVATION OF D TO READ:

D = least horizontal distance between tube centers on a horizontal row, in.

IMMEDIATELY BELOW THE DERIVATION OF LETTERS INSERT:

Where tubes are staggered the vertical distance between the center lines of tubes in adjacent rows must be not less than $\frac{1}{2}\sqrt{2dD + d^2}$

PAGE 61

PAR. 239. CHANGE FIRST SECTION OF PAR. 239 TO READ AS FOLLOWS:

239 *Plain Circular Furnaces.* Unstayed furnaces *more than 18 in. diameter* when riveted or of seamless construction, or such furnaces when lapwelded by the forging process, shall have walls not less than 5/16 in. thick. The maximum allowable working pressure for such furnaces shall be determined by one or the other of the following formulae:

MAKE DEFINITION OF L READ AS FOLLOWS:

L = total length of furnace between centers of head rivet seams (not length of a section), in.

INSERT AFTER THE FORMULA AND JUST PRECEDING THE EXAMPLE IN PAR. 239, THE FOLLOWING, ELIMINATING THE PRESENT SENTENCE:

Where the furnace has a riveted logitudinal joint, it may be of the lap type for inside diameters not exceeding 36 in. for furnaces 36 in. or less in height or length, and for inside diameters not exceeding 30 in., irrespective of the height or length. Otherwise butt and strap construction shall be used. The efficiency of the joint shall be greater than:

$$\frac{P \times D}{1250 \times T}$$

PAGE 64

PAR. 245. CHANGE PAR. 245 TO READ AS FOLLOWS:

245 *Cast-iron and Malleable Iron Headers.* The pressure allowed on a water-tube boiler shall not exceed 160 lb. per sq. in. when the tubes are secured to cast-iron headers, nor 200 lb. when the tubes are secured to malleable iron headers. The form and size of the internal cross section perpendicular to the longer axis of a cast-iron or malleable iron header at any point shall be such that it will fall within a 7 in. by 7 in. rectangle.

PAR. 246. CHANGE NUMBER OF PAR. 246 TO PAR. 246*a* AND CHANGE THE WORD "WITH" IN SECOND LINE TO "TO."

PAR. 247. CHANGE NUMBER OF PAR. 247 TO PAR. 246*b* AND REVISE IT TO READ AS FOLLOWS:

b A cast-iron header when tested to destruction, shall withstand a hydrostatic pressure of at least 1200 lb. per sq. in. and a malleable-iron header, 1500 lb. A hydrostatic test at 400 lb. per sq. in. for cast iron and 500 lb. per sq. in. for malleable iron shall be made on all new headers with tubes attached.

PAR. 247. INSERT A NEW PAR. 247 TO READ AS FOLLOWS:

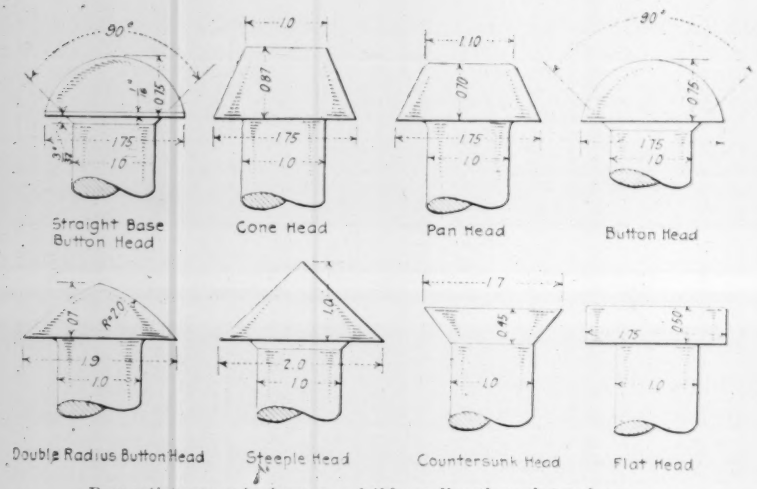
247 Where it is impossible to calculate with a reasonable degree of accuracy the strength of a boiler structure or any part thereof, a full sized sample shall be built by the manufacturer and tested to destruction in the presence of the Boiler Code Committee or one or more representatives of the Boiler Code Committee appointed to witness such test.

PAR. 250. CHANGE PAR. 250 TO READ AS FOLLOWS:

250 A fire-tube boiler shall have the ends of the tubes substantially rolled and beaded, or rolled and welded, at the firebox or combustion chamber end.

PAR. 251. CHANGE PAR. 251 TO READ AS FOLLOWS:

251 The ends of all tubes, suspension tubes and nipples shall be flared not less than $\frac{1}{8}$ in. over the diameter of the tube hole on all water-tube boilers and superheaters, or they may be flared not less than $\frac{1}{8}$ in., rolled and beaded, or flared, rolled and welded.



Proportions may be larger or 1/10 smaller than those shown.
Fillets under heads may be used but are not required.

FIG. 17A ACCEPTABLE FORMS OF RIVET HEADS

PAGE 65

PAR. 253. CHANGE PAR. 253 TO READ AS FOLLOWS:

253 *Drilling of Holes.* All rivet holes and staybolt holes and holes in braces and lugs shall be drilled full size or they may be punched not to exceed $\frac{1}{4}$ in. less then full diameter for material over 5-16 in. in thickness, and $\frac{1}{8}$ in. less than full diameter for material not exceeding 5-16 in. in thickness, and then drilled or reamed to full diameter. Plates, butt straps, braces, heads and lugs shall be bolted in position for drilling or reaming all rivet holes in boiler plates except those used for the tack bolts required in assembling. Tack bolts for seams shall be not over 12 in. apart.

PAR. 254. CHANGE PAR. 254 TO READ AS FOLLOWS:

254 After drilling or reaming rivet holes the plates and butt straps shall be separated, the burrs and chips removed, the plates and butt straps reassembled metal to metal with barrel pins fitting the holes, and with tack bolts.

PAR. 255. ADD TO PAR. 255 THE FOLLOWING:

Forms of rivet heads that will be acceptable are shown in Fig. 17*a*.

PAR. 256. CHANGE PAR. 256 TO READ AS FOLLOWS:

256 Rivets shall be machine driven wherever possible with sufficient pressure to fill the rivet holes, and shall be allowed to cool and shrink under pressure. Barrel pins fitting the holes and tack bolts shall be used. The tack bolts shall be not over 12 in. apart, and a rivet shall be driven each side of each tack bolt before removing the tack bolt.

PAR. 257. CHANGE PAR. 257 TO READ AS FOLLOWS:

257 *Calking.* The calking edges of plates, butt straps and heads shall be beveled. Every portion of the sheared surfaces of the calking edges of plates, butt straps and heads shall be planed, milled or chipped to a depth of not less than $\frac{1}{8}$ in. calking shall be done with a round-nosed tool.

PAR. 258. CHANGE SIDEHEAD IN PAR. 258 TO READ AS FOLLOWS:

Manholes and Handholes.

ADD TO PAR. 258 THE FOLLOWING:

A handhole opening in a boiler, the greatest dimension of which exceeds 6 in., shall be reinforced in accordance with the rules for manholes.

PARS. 260-261

The Executive Committee of the Boiler Code Committee will report later respecting openings that need not be reinforced and on methods of reinforcing openings that need not come under the same rules as for manholes.

PAGE 67

PAR. 261. CHANGE THE TWO LINES OF PAR. 261 AT THE TOP OF PAGE 67 TO READ AS FOLLOWS:

l = length of center line of opening in shell in direction parallel to axis of shell plus the sum of the diameters of the rivet holes that come in or adjacent to the center line of the opening, in.

PAR. 266. CHANGE PAR. 266 TO READ AS FOLLOWS:

266 A vertical fire-tube boiler, except boilers of steam fire-engines, or boilers 24 in. or less in diameter, shall have not less than seven handholes, located as follows: Three in the shell at or about the line of the crown sheet; one in the shell at or about the water-line or opposite the fusible plug when used; three in the shell at the lower part of the waterleg. A vertical fire-tube boiler, submerged tube type, shall have two or more handholes in the shell, in line with the upper tube sheet. All boilers 24 in. or less in diameter shall have at least one opening for inspection and one opening in addition to the blow-off for washing out the boiler, these openings to be fitted with brass plugs.

PAGE 68

PAR. 268. CHANGE PAR. 268 TO READ AS FOLLOWS:

268 *Threaded Openings.* A pipe connection 1 in. in diameter or over shall have not less than the number of threads given in Table 7.

TABLE

If the thickness of the material in the boiler is not sufficient to give such number of threads, the opening shall be reinforced by a pressed steel, cast steel, or bronze composition flange, or plate, so as to provide the required number of threads.

When the maximum allowable working pressure exceeds 100 lb. per sq. in., a flanged nozzle shall be used for all pipe openings over 3 in. pipe size.

PAR. 269. CHANGE PAR. 269 TO READ AS FOLLOWS:

269 *Safety Valve Requirements.* Each boiler shall have two or more safety valves, except a boiler for which one safety valve having a relieving area of $\frac{1}{2}$ sq. in. or less, is required by the rules.[1]

PAGE 69

PAR. 272. CHANGE PAR. 272 TO READ AS FOLLOWS:

272 Safety valves may be of the direct spring loaded pop type with seat and bearing surface of the disc inclined at any angle between 45 deg. and 90 deg. to the center line of the spindle. The valve shall be rated at a pressure 3 per cent in excess of that at which the valve is set to blow.

[1] The method of computing the relieving area of the safety valves shall be as given in Par. 421 of the Appendix.

Safety valves may be used which give any opening up to the full discharge capacity of the area of the opening at the base of the valve, provided the movement of the valve is gradual so as not to induce lifting of the water in the boiler.

All safety valves shall be so constructed that no detrimental shocks are produced through the operation of the valve. Weighted lever safety valves shall not be used.

PAR. 273. CHANGE PAR. 273 TO READ AS FOLLOWS:

273 Each safety valve shall be plainly marked by the manufacturer. The markings may be stamped on the body, cast on the body, or stamped or cast on a plate or plates riveted to the body, and shall contain the following:

a The name or identifying trademark of the manufacturer
b The nominal diameter
c The steam pressure at which it is set to blow
d Blow down, or difference between the opening and closing pressures
e The weight of steam discharged in pounds per hour at a pressure 3 per cent higher than that for which the valve is set to blow
f A.S.M.E. Std.

PAR. 274. CHANGE PAR. 274 TO READ AS FOLLOWS:

274 The minimum allowable relieving capacity of the safety valve or valves required on a boiler shall be determined on the basis of 6 lb. of steam per hour per sq. ft. of boiler heating surface for water tube boilers. For all other types of power boilers with pressures above 100 lb., the minimum allowable relieving capacity shall be determined on the basis of 5 lb. of steam per hour per sq. ft. of boiler heating surface, and on the basis of 3 lb. with pressures at or below 100 lb. per sq. in. The heating surface shall be computed for that side of the boiler surface exposed to the products of combustion, exclusive of the superheating surface. In computing the heating surface for this purpose only the tubes, fireboxes, shells, tube sheets and the projected area of headers need be considered. The minimum number of safety valves required shall be determined on the basis of the minimum allowable relieving capacity and the relieving capacity marked on the valves by the manufacturer.

PAGES 70-71-72

TABLE 8. TRANSFER TABLE 8 TO THE APPENDIX AFTER PAR. 427 AND RENUMBER AS TABLE 16.

PAGE 73

PAR. 275*a*. CHANGE PAR. 275*a* TO READ AS FOLLOWS:

275 Safety valve capacity may be checked in any one of the three following ways, and if found insufficient, additional capacity shall be provided:

a By making an accumulation test; that is, by shutting off all other steam discharge outlets from the boiler and forcing the fires to the maximum. The safety valve equipment shall be sufficient to prevent an excess pressure beyond that specified in Par. 270.

PAGE 74

PAR. 279. ADD TO THE END OF PAR. 279 THE FOLLOWING:

Where discharge pipes are used, the cross-sectional area at any point shall be at least equal to the combined areas of the discharge outlets of the valves discharging therethrough. Ample drainage shall be provided at or near each safety valve and where the water of condensation may collect.

PAR. 282. CHANGE PAR. 282 TO READ AS FOLLOWS:

282 To insure the valve being free, each safety valve shall have a substantial lifting device by which the valve may be raised from its seat at least 1-16 in. when there is no pressure on the boiler.

PAR. 283. ADD TO PAR. 283 THE FOLLOWING:

The seats and discs of safety valves shall be of non-ferrous material. The seat of a safety valve shall be fastened to the body of the valve in such a way that there is no possibility of the seat lifting.

PAR. 284. CHANGE PAR. 284 TO READ AS FOLLOWS:

284 Springs used in safety valves shall not show a permanent set exceeding 1-16 in. ten minutes after being released from a cold compression test closing the spring solid. The spring shall be so constructed that the valve can lift from its seat at least 1-10 the diameter of the seat before the coils are closed or before there is other interference.

PAR. 286. CHANGE PAR. 286 TO READ AS FOLLOWS:

286 The dimensions of flanges subjected to boiler pressue shall conform to the American Standard given in Tables 15 and 16 of the APPENDIX for the pressures therein specified, except that the face of the safety valve flange and the nozzle to which it is attached may be flat and without the raised face for pressures up to and including 250 lb. per sq. in. For higher pressures, the raised face shall be used.

PAR. 287. CHANGE PAR. 287 TO READ AS FOLLOWS:

287 When the valve body is marked with the letters A.S.M.E. Std. as required by Par. 273, this shall be a guarantee by the manufacturer that the valve conforms to the details of construction herein specified.

PAR. 288. CHANGE PAR. 288 TO READ AS FOLLOWS:

288 Every superheater shall have one or more safety valves near the outlet. The discharge capacity of the safety valve or valves on an attached superheater may be included in determining the number and size of the safety valves for the boiler, provided there are no intervening valves between the superheater safety valve and the boiler, and provided the discharge capacity of the safety valve or valves on the boiler, as distinct from the superheater, is at least 75 per cent. of the total valve capacity required.

PAGE 75

PAR. 290. CHANGE PAR. 290 TO READ AS FOLLOWS:

290 Every boiler shall have proper outlet connections for the required safety valve or valves, independent of any other outside steam connection, the area of opening to be at least equal to the aggregate nominal area of all of the safety valves to be attached thereto.

An internal collecting pipe, splash plate or pan may be used, provided the total area for inlet of steam thereto is not less than one and one-half times the aggregate area of the attached safety valves. The holes in collecting pipes shall be at least $\frac{1}{4}$-in. in diameter and the least dimension in any other form of opening for inlet of steam shall be $\frac{1}{4}$-in.

PAR. 291. CHANGE PAR. 291 TO READ AS FOLLOWS:

291 *Water Gage Glasses and Gage Cocks.* Each boiler shall have at least one water gage glass, the lowest visible part of which shall be not less than 2 in. above the lowest permissible water level. The lowest permissible water level for various classes of boilers shall be the location for the fusible plug as given in Par. 430 of the APPENDIX.

PAR. 292. CHANGE PAR. 292 TO READ AS FOLLOWS:

292 No water glass connection shall be fitted with an automatic shut-off valve, except when the automatic shut-off valves are so constructed that the two connections to the water glass can be blown through separately and the steam connection cannot be entirely closed thereby. Where automatic water gages are applied they shall conform to the following requirements:

1. Check valves in upper and lower fittings must be of the non-ferrous ball type to avoid corrosion and the necessity for guides.

2. Ball check valves in upper and lower fittings must open by gravity, and the lower ball check valve must rise vertically to its seat.

3. The ball checks must not be smaller than $\frac{1}{2}$-in. diameter, and the diameter of the circle of contact with

the seat must not be greater than $\frac{2}{3}$ of the diameter of the ball check valve. The annulus around the ball must not be less than $\frac{1}{8}$-in., and the travel movement from the normal resting place to the seat must not be less than $\frac{1}{4}$-in. The balls must be accessible for inspection.

4. The chambers in upper and lower fittings through which the balls pass on the way to their respective seats must be either square or hexagonal in shape.

5. The ball seat in the upper fitting must be a flat seat with either a square or hexagonal opening so that the stream passage can never be completely closed by this valve.

6. The shut-off valve in the upper fitting must have a projection which holds the ball at least $\frac{1}{4}$-in. away from its seat when the shut-off valve is closed.

7. The lower fitting must be provided with a positive means of rotating the ball. Means must also be provided for removal and inspection of lower ball check valve, while the boiler is under steam pressure.

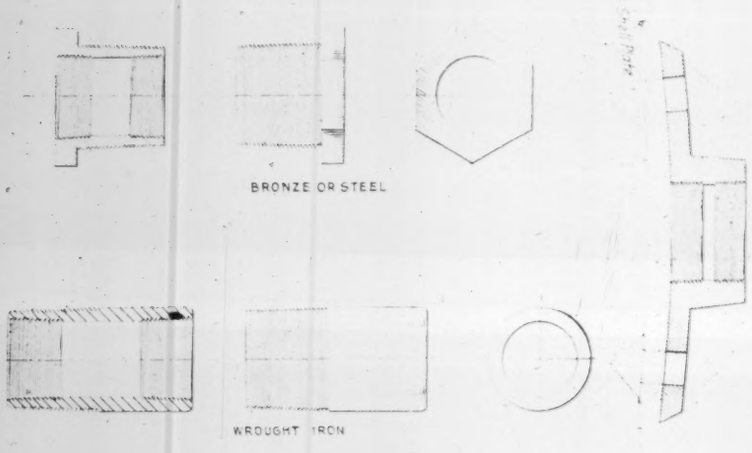


FIG. 18A TYPES OF BOILER FLANGES AND BUSHINGS

PAR. 296. ADD TO THE END OF PAR. 296 THE FOLLOWING:

Where the use of a long pipe becomes necessary, a shut-off valve or cock arranged so that it can be locked or sealed open may be used near the boiler. Such a pipe shall be of ample size and arranged so that it may be cleared by blowing out. Each boiler shall be provided with a $\frac{1}{4}$-in. pipe size valved connection for exclusive purpose of attaching a test gage.

PAGE 76

PAR. 299. CHANGE PAR. 299 TO READ AS FOLLOWS:

299 *Nozzles and Fittings.* Flanged cast iron pipe fittings used for boiler parts, for pressures up to and including 160 lb. per sq. in., shall conform to the American Standard given in Tables 15 and 16 of the APPENDIX, except that the face of the flange of a safety valve as well as that of a safety valve nozzle, may be flat and without the raised face. For pressures above 160 lb. per sq. in., cast iron shall not be used for boiler pressure parts with exceptions specified in Pars. 9, 12 and 245. An allowable variation of 20 per cent from the flange thickness required by Tables 15 and 16 may be made for steel cast and forged steel fittings, leaving the drilling of bolt holes unchanged. For pressures above 250 lb. per sq. in., the flange thickness and the thickness of the bodies shall be increased to keep within the same deflection limits and to give at least the same factor of safety as the fittiags specified in Tables 15 and 16. The flange of a safety valve may have a flat face for pressures up to and including 250 lb. per sq. in., and shall have a raised face at higher pressures; a safety valve nozzle may have a flat face for pressures up to and including 250 lb. per sq. in. and shall have a raised face at higher pressures. Tables 15 and 16 do not apply to flanges on the boiler side of steam nozzles or to flanges left by the manufacturer as part of the boiler, and do not apply to fittings designed as part of the boiler.

PAR. 307. CHANGE PAR. 307 TO READ AS FOLLOWS:

307 *Blow-off Piping.* A surface blow-off shall not exceed $1\frac{1}{2}$ in. pipe size and the internal and external pipes, when used, shall form a continuous passage, but with clearance between their ends and arranged so that the removal of either will not disturb the other. A properly designed brass or steel bushing as shown in Fig. 18A or flanged connection, shall be used.

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PAR. 311. CHANGE PAR. 311 TO READ AS FOLLOWS:

311 *a* On all boilers except those used for traction and portable purposes, when the maximum allowable working pressure exceeds 125 lb. per sq. in., each bottom blow-off pipe shall have two valves, or a valve and a cock, and such valves, or valve and cock, shall be extra heavy, except that on a boiler having multiple blow-off pipes, a single master valve may be placed on the common blow-off pipe from the boiler, in which case only one valve on each individual blow-off is required.

b All traction and portable boilers shall have a bottom blow-off valve; when the maximum allowable working pressure exceeds 125 lb. per sq. in., the blow-off valve shall be extra heavy.

PAR. 314. OMIT THE LAST SENTENCE SO THAT PAR. 314 READS AS FOLLOWS:

314 *Feed Piping.* The feed pipe of a boiler shall have an open end or ends inside of the boiler.

PAR. 315. CHANGE THE LAST SENTENCE OF PAR. 315 TO READ AS FOLLOWS:

The feed pipe shall be carried through the head or shell near the front end in the manner specified for a surface blow-off in Par. 307, and be securely fastened inside the shell above the tubes.

ADD TO PAR. 315 THE FOLLOWING:

In Fig. 18*a* is illustrated a standard form of flange for use on boiler shells for passing through piping such as feed, surface, blow-off connections, etc., and which permits of the pipes being screwed in solid from both sides in addition to the reinforcing of the opening in the shells.

In other types of boilers where both internal and external pipes making a continuous passage are employed, the boiler bushing or its equivalent shall be used.

PAR. 317. ADD TO PAR. 317 THE FOLLOWING:

Wherever globe valves are used on feed piping, the inlet shall be under the disc of the valve.

PAGE 79

PAR. 325. CHANGE PAR. 325 TO READ AS FOLLOWS:

325 Lugs or brackets, when used to support a boiler of any type, shall be properly fitted to the surfaces to which they are attached. The shearing and crushing stresses on the rivets used for attaching the lugs or brackets shall not exceed 8 per cent of the strength given in Pars. 15 and 16. For traction or portable boilers, studs with pipe threads may be used.

PAR. 328. CHANGE PAR. 328 TO READ AS FOLLOWS:

328 A water-tube boiler shall have the firing doors, furnace inspection doors and clinker doors of the inward opening type, unless such doors are provided with substantial and effective latching or fastening devices to prevent them from being blown open by pressure on the furnace side.

PAR. 332. CHANGE PAR. 332 TO READ AS FOLLOWS:

332 After obtaining the stamp to be used when boilers are to be constructed to conform with the A.S.M.E. Boiler Code, it is understood that a state inspector, municipal inspector, or an inspector employed regularly by an insurance company which is authorized to do a boiler insurance business in the state in which the boiler is built and in the state in which it is to be used, is to be notified that an inspection is to be made and shall inspect such boilers during construction and after completion. At least two inspections shall be made, one before reaming rivet holes and one at the hydrostatic test. In stamping the boiler after completion, if built in compliance with the Code, the builder shall stamp the boiler in the presence of the inspector, after the hydrostatic test, with the A.S.M.E. Code stamp, the builder's name and the serial number of the manufacturer. A data sheet shall be filled out and signed by the manufacturer and the inspector. This data sheet together with the stamp on the boiler shall denote that it was constructed in accordance with the A.S.M.E. Boiler Code.

The name of the state in which the boiler is built shall be stamped under and about one-half inch below the symbol. The name or initials of the manufacturer shall be stamped below the name of the state, together with the serial number of the boiler, and not over one-half inch therefrom. (Samples of data sheets appear in the APPENDIX, after page 120.)

Stamps for the official symbol shown in Fig. 19 are obtainable from THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

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REVISE FIG. 20 TO READ AS FOLLOWS:

(Name of State)
.....STD
(Manufacturer's number of boiler)
.....1
(Name and location of builder)
Installation No.) (Name of State)
.....1
(Year put into service)
.....

PAGE 81

HEADING. MAKE HEADING OF P. 81 READ AS FOLLOWS:

A.S.M.E. Boiler Code

PART I—SECTION II

BOILERS USED EXCLUSIVELY FOR LOW PRESSURE STEAM AND HOT WATER HEATING AND BOILERS FOR HOT WATER SUPPLY.

PAR. 335. CHANGE CENTER HEAD ABOVE.

PAR. 335 FROM "BOILER MATERIALS" TO "GENERAL."

PAR. 336. INSERT ABOVE PAR. 336 THE FOLLOWING CENTER HEAD: "MATERIALS."

PAR. 339. CHANGE PAR. 339 TO READ AS FOLLOWS:

339 A boiler to be used exclusively for low pressure steam heating may be constructed either of cast iron, steel cast, or wrought iron or steel, or any combination of these, but in all cases the connecting rods and bolts shall be wrought iron or steel.

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PAR. 343. REVISE THE WORDING OF PAR. 343 AS FOLLOWS, AND ARRANGE IT AS A SINGLE PARAGRAPH:

343 In a *hot-water* boiler to be used exclusively for heating buildings or hot-water supply, when the diameter does not exceed 60 in. and the grate area does not exceed 10 sq. ft., or equivalent as defined in Pars. 359 and 360, longitudinal lap joints will be allowed. When the grate area exceeds 10 sq. ft., or equivalent as defined in Pars. 359 and 360, and the diameter of the boiler does not exceed 60 in., longitudinal lap joints will be allowed provided the maximum allowable working pressure does not exceed 50 lb. per sq. in.

PAR. 345. CHANGE PAR. 345 TO READ AS FOLLOWS:

345 A boiler used for low pressure steam heating or for hot water supply shall be provided with washout holes for the removal of any sediment that may accumulate therein. Steel shell boilers of the locomotive or vertical fire-tube type shall conform to the requirements of Pars. 265 and 266 for washout holes.

PAR. 347. IN FOURTH LINE OMIT THE FOLLOWING WORDS:

"Or any internal pipe in the boiler."

PAR. 354. CHANGE PAR. 354 TO READ AS FOLLOWS:

354*a*. No shut-off of any description shall be placed between the safety or water relief valves and boilers, nor on discharge pipes between them and the atmosphere.

b. No boiler for hot water supply shall be connected to a water supply pipe fitted with a check valve or pressure reducing valve.

PAGE 84

TABLE 9. TITLE OF TABLE 9 TO BE CHANGED TO READ AS FOLLOWS:

Allowable Sizes of Safety Valves for Steam Heating Boilers, of Water Relief Valves for Water Heating Boilers, and of Hot Water Supply Boilers.

PAR. 356. CHANGE PAR. 356 TO READ AS FOLLOWS:

356 Each safety valve used on a *steam* heating boiler shall have a substantial lifting device by which the valve may be raised from its seat at least 1/16 in. when there is no pressure on the boiler.

PAGE 85

PAR. 359. INSERT THE FOLLOWING CENTER HEAD ABOVE PAR. 359:

GRATE AREA

PAR. 359. CHANGE PAR. 359 TO READ AS FOLLOWS:

359 *Double Grate Down Draft Boilers.* In boilers of this type the grate area shall be taken as one and one-quarter times the area of the larger grate.

PAR. 361. CHANGE PAR. 361 TO READ AS FOLLOWS:

361 *Steam Gages.* Each *steam* boiler shall have a steam gage connected to the steam space or to the water column, or its steam connection, by means of a syphon or equivalent device of sufficient capacity to keep the gage tube filled with water and so arranged that the gage cannot be shut off from the boiler except by a cock placed near the gage and provided with a tee or lever handle, arranged to be parallel with the pipe in which it is located when the cock is open. Connections to gages shall be of brass, copper or bronze composition. The dial of a steam gage for a *steam* heating boiler shall be graduated to not less than 30 lb.

PAGE 86

PAR. 363. ADD TO PAR. 363 THE FOLLOWING:

Temperature Regulator. A temperature regulator shall be applied to *hot water* supply boilers which will prevent the water temperature from rising above 200 deg. fahr.

PAR. 365. CHANGE PAR. 365 TO READ AS FOLLOWS:

365 *Damper Regulators.* When a pressure damper regulator is used, it shall be connected to the steam space of the boiler.

[1] Domestic kitchen range boilers and their water backs, furnace heating coils and their appurtenances and domestic coil or pipe, gas or oil heaters, are not included under this Section.

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PAR. 373. CHANGE PAR. 373 TO READ AS FOLLOWS:

373 *Hot-water* boilers for a maximum allowable working pressure not exceeding 30 lb. per sq. in., used exclusively for heating buildings or for hot-water supply, when constructed of cast iron, steel cast, or wrought iron or plate steel or any combination of these, shall be subjected to a shop test of 60 lb. per sq. in. hydrostatic pressure applied to the boiler or the section thereof.

PAR. 374. CHANGE PAR. 374 TO READ AS FOLLOWS:

374 A maximum allowable working pressure in excess of 30 lb. per sq. in. will be allowed on a hot-water boiler constructed of cast iron, steel cast, or wrought iron or plate steel or any combination of these, used exclusively for heating buildings or for hot-water supply, provided such boilers or their sections have been subjected to a shop hydrostatic test of two and one-half times the actual working pressure.

PAR. 377. CHANGE PAR. 377 TO READ AS FOLLOWS:

377 *Name.* All boilers referred to in this section shall be plainly and permanently marked with the manufacturer's name and the maximum allowable working pressure.

All heating boilers built according to these rules may be marked A.S.M.E. standard.

PAGE 89

HEADING. INSERT ABOVE HEADING OF P. 89 THE FOLLOWING:

A.S.M.E. Boiler Code

PAGE 90

PAR. 384. CHANGE PAR. 384 TO READ AS FOLLOWS:

384 The shell or drum of a boiler in which a typical "lap seam crack" is discovered along a longitudinal riveted joint for either butt seam or lap joints shall be permanently discontinued for use under steam pressure. By "lap seam crack" is meant the typical crack frequently found in lap seams extending parallel to the longitudinal joint and located either between or adjacent to rivet holes.

PAGE 91

PAR. 391*a*. CHANGE PAR. 391*a* TO READ AS FOLLOWS:

a By making an accumulation test, that is, by shutting off all other steam discharge outlets from the boiler and forcing the fires to the maximum. The safety valve equipment shall be sufficient to prevent an excess pressure beyond that specified in Par. 270.

PAR. 392. CHANGE PAR. 392 TO READ AS FOLLOWS.

392 In case either of the methods outlined in sections *b* or *c* of Par. 391 is employed, the safety valve capacities shall be those given in Table 16.

PAGE 95—APPENDIX

HEADING. INSERT ABOVE HEADING OF PAGE 95 THE FOLLOWING:

A.S.M.E. Boiler Code

PAGE 93

PAR. 402. CHANGE PAR. 402 TO READ AS FOLLOWS:

402 When the maximum allowable working pressure exceeds 125 lb. per sq. in., the blow-off pipe shall be extra heavy from boiler to valve or valves, and shall run full size without reducers or bushings. All fittings between the boiler and valve shall be steel or extra heavy fittings of bronze, brass, malleable iron or cast-iron. In case of replacement of pipe or fittings in the blow-off lines, as specified in this paragraph, they shall be installed in accordance with the rules for new installations. (See Pars. 307-313.)

PAR. 403. ADD TO PAR. 403 THE FOLLOWING:

In case of replacement of pipe or fittings in the blow-off lines as specified in this paragraph, they shall be installed in accordance with the rules for new installations. (See Pars. 307-313.)

PAR. 408. CHANGE PAR. 408 TO PAR. 408*a*.

PAR. 409. CHANGE PAR. 409 TO PAR. 408*b* AND INSERT A NEW PAR. 409 AS FOLLOWS:

Where repairs are necessary which in any way affect the working pressure or safety of a boiler, a state inspector, municipal inspector, or an inspector employed regularly by an insurance company which is authorized to do a boiler insurance business in the state in which the boiler is used, shall be called for consultation and advice as to the best method of making such repairs; after such repairs are made they shall be subject to the approval of a state inspector, municipal inspector, or an inspector regularly employed by an insurance company which is authorized to do a boiler insurance business in the state in which the boiler is used.

PAGE 95

HEADING. INSERT ABOVE HEADING OF P. 95 A.S.M.E. BOILER CODE.

PAGE 103

PAR. 417

CHANGE FIRST SENTENCE OF PAR. 417 TO READ AS FOLLOWS:

417 Figs. 28 and 29 illustrate other joints that may be used in which eccentric stresses are avoided.

PAGE 107

PAR. 421. CHANGE PAR. 421 TO READ AS FOLLOWS:

421 *Method of Computing Discharge Capacity.* The required discharge capacity of a safety valve or valves for a boiler may be based either on the heat units in the fuel consumed or on the amount of steam generated.

The number of heat units that each safety valve will handle, for valves of the ordinary types in which the discharge capacity is proportioned to the lift, may be obtained as follows:

$U = 161{,}000 \times P \times D \times L$ for Bevel Seats at 45 deg.
$U = 227{,}500 \times P \times D \times L$ for Flat Seats
$U = 72{,}500 \times P \times A$ for seats of any angle

The amount of steam that a valve will discharge may be found as follows:

$W = 110 \times P \times D \times L$ for Bevel Seats at 45 deg.
$W = 155 \times P \times D \times L$ for Flat Seats
$W = 50 \times P \times A$ for seats of any angle

where

U = Number of heat units per hour that a safety valve will handle, B.t.u.
W = Quantity of steam that a safety valve will handle per hour, lb.
P = Absolute boiler pressure = gage pressure + 14.7 lb. per sq. in.
D = Inside diameter of valve seat, in.
L = Vertical lift of valve disc, measured with 3 per cent excess pressure, in.
A = Relieving area in sq. in. = $3.1416 \times D \times L \times$ sine of seat angle.

PAR. 422. CHANGE PAR. 422 TO READ AS FOLLOWS:

422 The maximum quantity of fuel C that can be burned per hour at the time of maximum forcing is determined by a test. The maximum number of heat units per hour, or $C \times H$ is then determined, using the values of H given in Par. 427. The weight of steam generated per hour is found by the formula:

$$W = \frac{C \times H \times 0.75}{1{,}100}$$

The sum of the safety valve capacities marked on the valves shall be equal to or greater than W.

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PAR. 423. REPLACE MATTER AFTER STATEMENT OF EXAMPLE BY THE FOLLOWING:

$$C \times H = 2150 \times 12,100 = 26,015,000$$
$$W = C \times H \times 0.75 \div 1100 = 17,740$$

A $3\frac{1}{2}$ in. bevel seated valve with 0.11 in. lift would discharge in heat units

$$U = 161,000 \times 239.7 \times 3\tfrac{1}{2} \times 0.11$$
$$= 14,858,000$$

and in weight of steam

$$W = 110 \times 239.7 \times 3\tfrac{1}{2} \times 0.11$$
$$= 10,150$$

From which it can be seen that either method indicates that two such valves will give the proper relieving capacity.

PAR. 424. REPLACE MATTER AFTER STATEMENT OF EXAMPLE BY THE FOLLOWING:

$$C \times H = 2000 \times 6400 = 12,800,000$$
$$W = C \times H \times 0.75 \div 1100 = 8730$$

A bevel seated $3\frac{1}{2}$ in. valve is marked by the manufacturer 0.11 in. lift and discharge capacity for 100 lb. pressure = 4840 lb.; hence two such valves would be required.

ALSO CHANGE HEADINGS IN TABLES FOLLOWING THIS SENTENCE TO READ AS FOLLOWS:

H = B.t.u. per lb.
and H = B.t.u. per cu. ft.

PAGE 111

TABLE 16

TABLE 16. THIS TABLE TO BE RENUMBERED. IN THE NOTES UNDER TABLE 16 ADD AFTER THE LAST SENTENCE THE FOLLOWING:

All extra heavy fittings and flanges to have a raised surface of 1/16 in. high inside of bolt holes for gaskets.

PAGE 113—APPENDIX

PAR. 428. ADD AT THE END OF PAR. 428:

and shall be renewed at least once each year.

PAR. 430. ADD THE FOLLOWING CLAUSE TO THE END OF PAR. 430:

v Fire Engine Boilers are not usually supplied with fusible plugs. Unless special provision is made to keep the water above the firebox crown sheet other than by the natural water level, the lowest permissible water level shall be at least 3 in. above the top of the firebox crown sheet.

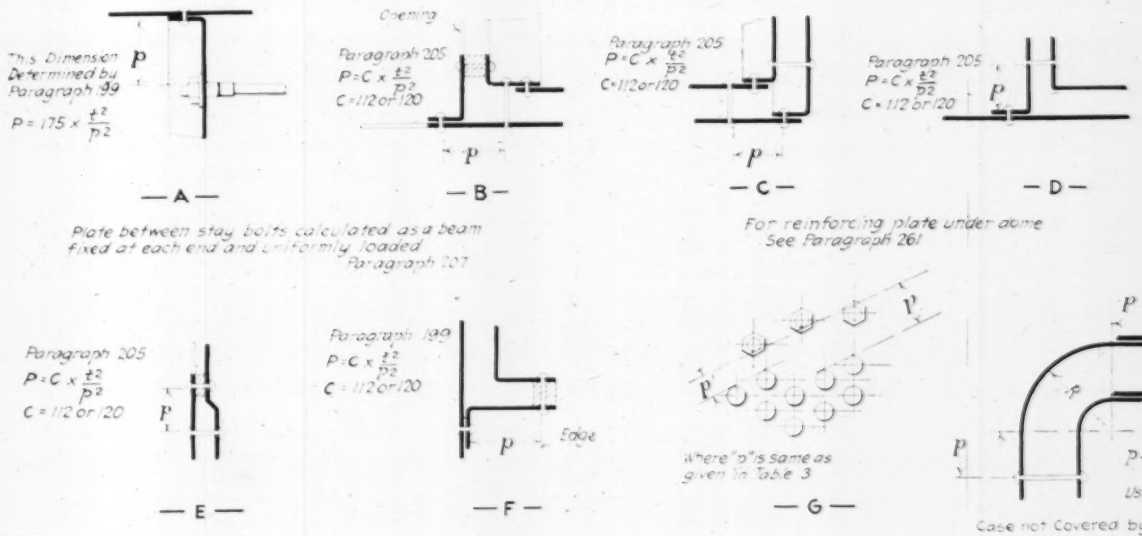

FIG. 31 DETAILS SHOWING APPLICATION OF PARS. 205, 206 AND 207 TO THE STAYING OF WET-BOTTOM BOILERS

PAR. 425. REPLACE MATTER AFTER STATEMENT OF EXAMPLE BY THE FOLLOWING:

$$C \times H = 1000 \times 18,500 = 18,500,000$$
$$W = C \times H \times 0.75 \div 1100 = 12,620$$

A bevel seated $2\frac{1}{2}$ in. valve is marked by the manufacturer 0.08 in. lift and discharge capacity for 275 lb. pressure = 6350 lb., hence two such valves would be required.

PAR. 426. REPLACE MATTER AFTER STATEMENT OF EXAMPLE BY THE FOLLOWING:

$$C \times H = 3000 \times 960 = 2,880,000$$
$$W = C \times H \times 0.75 \div 1100 = 1960$$

A bevel seated 2 in. valve is marked by the manufacturer 0.07 in. lift and discharge capacity for 150 lb. pressure = 2500 lb., hence one such valve would be required.

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PAR. 427. CHANGE FIRST SENTENCE OF PAR. 427 TO READ AS FOLLOWS:

427. For the purpose of checking the safety valve capacity as described in Par. 422, the following values of heats of combustion of various fuels may be used.

Under Table 3 reference is made to Fig. 31 showing application of Pars. 205, 206 and 207.

RECOMMENDATIONS FOR REPAIRS WHEN MADE BY WELDING AND REINFORCING BY THE ELECTRIC, OXY-ACETYLENE, OR OTHER PROCESSES

From General Rules and Regulations Prescribed by the Board of Supervising Inspectors, U. S. Steamboat-Inspection Service

"All calking edges on internally fired boilers may be reinforced by these processes.

"Calking edges of the shells of externally fired boilers, above the fire line only, may be reinforced.

"Cracks extending from edge of lap to rivet, except on seams below the fire line in externally fired boilers, may be welded.

"Cracks not exceeding 30 inches in length in back connec-

MANUFACTURERS' DATA REPORT OF BOILER
As Required by the Provisions of the A.S.M.E. Rules

1. Boiler manufactured by ..... at .....
2. Boiler manufactured for ..... of .....
3. Type of boiler **LOCOMOTIVE** and other Internally-Fired Boilers, **STATIONARY** ..... **BOTTOM** .....
(State if wet bottom or open bottom.)
SERIAL NO. .....
(Other forms to be used for HORIZONTAL RETURN TUBULAR and other Externally-Fired and Water Tube Boilers).
4. Shell plates and butt straps made by .....
5. (*a.*) Mill test report on shell plates: ..... Yield point .....
(Tensile strength. Lb. per sq. in.) (Lb. per sq. in.)
(*b.*) Elongation ..... %. Phos. ....0..... %. Sul. ....0..... %. Man. ....0.... to 0..... %
(In 8 inches.)
6. Mill test report on butt straps ..... Thickness ..... in.
(Brand and tensile strength.)
7. Stamps on shell plates ..... Thickness ..... in.
(Brand and tensile strength.)
8. Furnace sheets made by ..... Stamped ..... Thickness ..... in.
(Brand and tensile strength.)
9. Heads made by ..... Stamped ..... Thickness ..... in.
(Brand and tensile strength.)
10. Rivets made by ..... Material .....
11. Stays made by ..... Material .....
12. Channel or angle irons on heads ..... Upper tubes to shell ..... in.
(No. and size on each head.)
13. (*a.*) Stays above tubes .....
[No. each head, and type (through, head to head, or diagonal, welded or weldless) and net cross sectional area of each size of each type.]
(*b.*) ..... Area to be stayed ..... sq. in.
(Each head above tubes.)
(*c.*) Stays below tubes .....
[No. each head, and type (through, head to head, or diagonal, welded or weldless) and net cross sectional area of each size of each type.]
(*d.*) ..... Area to be stayed ..... sq. in.
(Each head below tubes.)
14. (*a.*) Stay bolts:—Made by ..... Material ..... Size ..... sq. in.
(Area at bottom of thread.)
(*b.*) Maximum pitch of .....in. × .....in.
[Circumferential (or Horizontal) × Vertical.]
15. **Shell:—Diam.** .....in. Length over all .....ft. .....in. No. of courses .....
(Inside of outside course.)
16. (*a.*) Longitudinal joints:—Type of ..... Riveting .....
(Double, triple, quad., etc.)
Diam. rivet holes .....in. Pitch of rivets ....."×....."×....." Efficiency of joint ..... %
(Minimum pitch on each row.)
(*b.*) Circumferential joints:—Type of ..... Riveting .....
Diam. rivet holes .....in. Pitch of rivets ....."×....."×....." Efficiency of joint ..... %
(Minimum pitch on each row.)
17. Tubes—No. .....Gage..... Diam. .....in. Length .....ft. .....in.
18. Steam outlets:—No. ..... Material of nozzle or reinforcement ..... Sizes ..... in.
(Cast steel or cast iron, pressed steel or steel plate.)
19. Grate area .....sq. ft.
20. Size of feed connection .....in. Size of bottom blow-off connection .....in.
21. Constructed for a max. allow. work. pressure of ..... lb. per sq. in. Tested to ..... lb. per sq. in.
(Hydrostatic pressure.)
22. If boiler has a dome, send working drawing of dome, also showing connection to boiler and openings in shell under dome.

REMARKS:— .....

.....

We certify the above data to be correct and that all details of **MATERIAL, CONSTRUCTION** and **WORKMANSHIP** on this boiler conform to the A.S.M.E. Rules.

(Signed) .....
(Manufacturer.)

..... 19 by .....

Received ..... 19 Checked ..... 19 by .....
Authorized State or Insurance Inspector.

Rules allow a max. allow. work. pressure of ..... lb. per sq. in., this being based on .....

FIG. 32 FRONT SIDE OF DATA SHEET FORM

CERTIFICATE OF BOILER SHOP INSPECTION

Insurance Company's Serial Number .....

BOILER WORKS OF ..... at .....

I, the undersigned, holding a certificate of competency as an inspector of steam boilers in THE STATE OF ....., and employed by the ..... of ....., inspected internally and externally, the boiler specified in this report, on ..... 19 , and certify that the statements made on this report are correct, corresponding with the mill test reports of material as furnished by the builders, and measurements made of the boiler when completed; and that this boiler is constructed in accordance with the A.S.M.E. Rules.

.....

Inspector of Boilers for State or Boiler Insurance Company.

FIG. 33 REAR SIDE OF DATA SHEET FORM

tion sheets, wrapper sheets, bottoms of combustion chambers, heads, and other stayed surfaces may be repaired by welding.

"Where cracks are repaired by welding, holes shall be drilled entirely through the plate at each extreme end of the crack, except in small cracks from rivet to calking edge.

"Circumferential or lengthwise cracks not exceeding 16 inches in length in plain or corrugated furnaces may be welded.

"Where plates in back sheets of back connections, wrapper sheets of sides and bottoms of back connections of any boilers, side sheets and legs of furnaces and bottoms of furnaces of fire-box boilers, and other stayed surfaces are reduced in thickness not exceeding 40 per cent of the original thickness, they may be reinforced, such reinforcing not to exceed an area of 200 square inches in any one plate.

"When such reinforcing extends over stays and braces, such stays and braces shall come completely through the reinforcing so as to be plainly visible to the inspectors.

"When the corroded portion of stayed or riveted surfaces of the back sheets or wrapper sheets or bottoms of back connections of any boilers, or side sheets and bottom sheets of furnaces or legs of fire-box boilers exceeds 300 square inches, the same may be repaired by the removal of the corroded portion and the replacement thereof by a new piece of plate, the edges of the new plate being welded in position.

"Staybolts, braces, or rivets shall pass through the body of the new plate as before, the area of the new piece not to exceed 24 inches by 24 inches, or 30 inches, in any one direction, the welded edges to be V'd or beveled along the joint prior to welding.

"Where plates of shells and other parts of internally fired boilers subject to tensile strain are reduced in thickness by corrosion not to exceed 25 per cent of the original thickness, they may be reinforced, such reinforcing not to exceed an area of 200 square inches.

"Where calking edges and laps have been reinforced, local inspectors shall require the rivets to be cut out and redriven if they find by inspection that it is necessary.

"No welding shall be allowed in cracks in the shell plates or other plates subject to tensile strain.

"Cracks extending through rivet holes in single-riveted or double-riveted seams in stayed surfaces of back connections of any boilers or side sheets of legs or bottoms of fire-box boilers which are stayed surfaces may be welded up to a length of 6 feet exclusive of rivet holes.

"Where cracks extend through rivet holes in stayed surfaces, the piece extending from the rivet to the edge of the lap may be removed where convenient to do so, and the place where the piece has been removed may be replaced by being built up and reinforced by either of these processes.

"Where leaks develop around staybolts and the staybolts are otherwise intact, the nuts may be removed from the ends of the staybolts, and the staybolts may be welded into the shell by welding a beveled collar or ring around the staybolt. The width and depth of such collar shall equal one-half of the diameter of the staybolt. In all such cases of applying welding rings or collars around staybolts, the material shall be hammered while in a glowing state as it is applied.

"In all cases where metal is deposited on stayed surfaces, the operator shall hammer, when practicable, the deposited metal while it is in a glowing state.

* * * * * *

"Cracks in wrought-iron or wrought-steel headers, and cracks or sand holes in cast-steel, semisteel, ferrosteel, malleable-iron or cast-iron headers, manifolds, crosses, tees, and ells may be repaired by welding cracks or flowing metal into sand holes. Such repaired material other than headers and manifolds shall be subjected to a hydrostatic test of three and one-half times the working pressure after such repairs are made. Reinforcing by building up of any of the above-mentioned articles other than headers shall not be allowed.

"When crown-bar bolts have deteriorated or wasted away at top of combustion chamber under the crown bars, such deterioration not to exceed 25 per cent of the original diameter of the bolt, such bolts may be built up or reinforced by any process of autogenous welding.

"Where tube sheets of boilers have deteriorated not to exceed 25 per cent of their original thickness, or where cracks have developed in tube sheets, the same may be reinforced and repaired by any process of autogenous welding, and the heading on the end of tubes may be welded to the tube sheets by the same process."

CORRESPONDENCE

CONTRIBUTIONS to the Correspondence Departments of The Journal by members of The American Society of Mechanical Engineers are solicited by the Publication Committee. Contributions particularly welcomed are suggestions on Society Affairs, discussions of papers published in The Journal, or brief articles of current interest to mechanical engineers.

The Logic of Inspection

TO THE EDITOR:

Referring to the paper on The Logic of Inspection, presented by Mr. A. L. De Leeuw at the Annual Meeting, I would say there are very few, if there are any, engineers who do not believe that inspection is the logical and final operation on any manufactured product. The question is, What relation should inspection have to the various machining operations; what form and type of gages should be used; and what manufacturing tolerances are to be permitted?

We will take a concrete example. Suppose it is necessary to manufacture a 3-in. American high-explosive shell. The conditions regarding the manufacture of this product are very clearly set forth in the Government specifications, and tolerances have also been established by the Ordnance Department. A complete outline of the proper methods of manufacture has also been given. The question for the manufacturer to decide is how he can best adapt his own equipment to the production of this particular product, what gages are necessary, and what are the most particular requirements which must be met.

It might be stated that the requirements for a high-explosive shell comprise several points, the more important ones being that the bore must be concentric with the external circumference within very definite limits, the shell prior to loading must be of a certain weight within definite limits, and the shape must conform to Government specifications.

Now, regarding the shape of a high-explosive shell, it might be stated that in order for it to follow the predetermined parabolic curve, the center of gravity of the shell must be in the right place. It is therefore evident that the shape of the shell must be such as to keep it in proper balance when in flight. The only parts of the shell that bear in the bore of the gun are that portion near the base of the ogive, and the rotating band. All other portions of the shell are free and do not contact with the bore. Hence, here are two points which must receive careful attention.

Regarding concentricity, as far as I know, no tolerances are given for this in the original U. S. specifications. The only complete specifications regarding tolerances and location of the center of gravity are the French, and they hold this one point to be more particular than any other. A shell which is not concentric, or, in other words, is out of balance, will not shoot accurately, and a shell in which the center of gravity is so placed

that it does not follow a predetermined curve will not shoot accurately. These questions which have to do with design are beyond the scope of the mechanical engineer and are up to the ballistic expert. The manufacturer, however, must meet the specifications as set down by these ballistic experts.

As an instance to show the importance of weight, it might be stated that when certain Canadian plants started to manufacture shells for the British Government they experienced great difficulty at first in producing shells which would pass the inspectors, owing to a misunderstanding regarding the requirements that had to be met. The shells were made within the desired tolerances for size as called for by the government specifications, but the weight of these shells was overlooked, and hence a large majority were rejected by the inspectors because of being short on the point of weight. It was found that when a shell was made to the minimum limits for diameter and length, it was below the minimum weight, and hence could not be accepted. Experience soon demonstrated to the Canadian manufacturers that the weight of the shell was just as important as any of the other requirements, and as a natural outcome of the difficulty, the shells were made to the tolerances called for by the government specifications, leaving the rear end of the shell longer than necessary. After the shell was completely machined, the base end was faced off until the desired weight was obtained. Points such as this proved to be of valuable assistance to the Canadian manufacturers in enabling them to meet their contracts.

While it is not my endeavor to discuss the subject fully, it is advisable, however, to state that gaging of the shell is no doubt the one operation that requires the most careful attention. Gages have been designed for shells that were not directly adapted to the work required of them, with the result that much work has been spoiled. One of the fundamental points regarding gaging is that the work should be located in the gage from the same point that it is located from when being machined, otherwise tolerances on the product cannot be set with any degree of certainty, and it is impossible to obtain interchangeable manufacture.

A point in connection with the paper presented by Mr. De Leeuw which was out of place, was his reference to the specification dealing with leather belting. This specification had nothing whatsoever to do with the inspection of leather belting, but what it did set forth was the process by which leather belting could be made in order to meet Government specifications, and as such would be of valuable assistance to any manufacturer engaged in this work who had not previously engaged in this particular line of manufacture.

The American Society of Mechanical Engineers can surely be of great assistance to our Government, but in order to do so it is necessary to get down to concrete cases rather than be satisfied with generalities. It is to be hoped that future papers presented before the Machine Shop Section of the A. S. M. E. will contain concrete and definite information on this interesting and important subject.

DOUGLAS T. HAMILTON.

Brooklyn, N. Y.

TO THE EDITOR:

In the first paragraph of his letter Mr. Douglas T. Hamilton says: "The question is, What relation should inspection have to the various machining operations; what form and type of gages should be used, and what manufacturing tolerances are to be permitted?" I fully realize that it was entirely out of the scope of the desired discussion to answer such questions as given above except in a very general way, and I attempted to bring out the necessity of careful consideration of such and other questions. I did not confine myself to the inspection of shells or ammunition because there is no essential difference between the rules which should govern the inspection of such materials and those for any other manufactured product.

That it is possible to give tolerances on the dimensions of a shell which conflict with the tolerances in regard to the weight of a shell shows conclusively that logic is required not merely to determine that there should be inspection, but also that specifications, limits, tolerances, etc., should be given in a logical manner.

Elsewhere Mr. Hamilton says: "Another point in connection with Mr. De Leeuw's paper, which appeared out of place, was his reference to the specification dealing with leather belting. This specification had nothing whatsoever to do with the inspection of leather belting, but what it did set forth was the process by which leather belting could be made in order to meet Government specifications, and as such would be of valuable assistance to any manufacturer engaged in this work who had not previously engaged in this particular line of manufacture." This last quotation shows quite clearly that Mr. Hamilton did not get the drift of what I said. The instance quoted in regard to specifications of leather belting were most decidedly taken from the specifications of users of leather belting; which means that belting not coming up to these specifications would be rejected by the user. I have copies of these specifications in my possession, and I would say that they were not written by the Government, but by some of the largest private concerns in this country. They were by no means information given by the user to some future belt maker, but instructions to an existing belt maker as to what he would have to furnish. The specifications were of such a nature that there was only one thing to do, and that was to take the word of the maker that he had followed the instructions, for the finished product would not show in any way that the specifications had been met. How Mr. Hamilton got the idea that these were Government specifications, and that they were made for the purpose of giving assistance to some future manufacturer, is more than I can tell.

Whether the papers presented before the Machine Shop Session of the A.S.M.E. at the last meeting were the papers most needed at the present time I do not care to discuss, but I feel that if the meeting had followed the lines of Mr. Hamilton's discussion, and had tried to consider in detail every feature of every piece of ordnance or ammunition which this Government may require, this meeting, starting Thursday afternoon, December 5, 1917, would probably have adjourned some Thursday afternoon in 1970! As to my share in the meeting, I merely tried to emphasize the necessity of logical inspection in order to make inspection not only profitable, but even possible.

A. L. DE LEEUW.

Plainfield, N. J.

Topographic surveys and mapping in relation to present military activities were discussed at a recent "patriotic" meeting of the American Institute of Mining Engineers by David White of the U. S. Geological Survey. There are 38 parties of topographers in the field, and the survey is now covering—on a scale of 1 mile to the inch—between 100,000 and 200,000 square miles per month. The survey has now one hundred men wearing the uniform of the United States.

SOCIETY AFFAIRS

A Record of the Current Activities of the Society, Its Members, Council, Committees, Sections and Student Branches; and an Account of Professional Affairs of Interest to the Membership

PROGRESS in the world has been through vicarious sacrifice, and the supreme benefit of this war, besides the attainment of opportunity for the self-determination of peoples great and small, is that of purification through the suffering caused by the war. It is essential that the suffering be for the good of others in order that one may benefit by the suffering.

One of the finest women I know, who has two sons at the front, and who has always, so far as one could observe, lived a life of service for others, recently told me that she is hoping that on the return of her boys she will be worthy to receive them.

We are constantly hearing of the failure to recognize the engineer in this war—that it is an engineering war; and President Taft, in his address before the Society at the Annual Meeting, said: "Now you engineers, all, constitute one of the two professions that are indispensable to the country in the carrying on of the struggle to which the people of the United States are about to devote themselves, yours and the medical profession; you as the constructors of all the material and all the equipment of which so much is needed now in modern warfare to make effective the work of our boys at the front, and the medical profession to furnish, so far as may be, the aid in restoring to the ranks those whom the fortunes of war disable."

Credit and recognition will be in the proportion that we unselfishly devote ourselves and make the sacrifices. It becomes increasingly difficult to receive with patience letters from members doubting the benefit that they obtain from the Society. It does not occur to them that membership in the Society is an opportunity to render greater service through an organization than could be rendered individually.

The Society is increasing its activities rapidly. The Presi-

THE SPRING MEETING AT WORCESTER

The following announcement regarding the convention to be held in Worcester, Mass., June 4 to 7, made by the Committee on Meetings and the Worcester Local Committee, evidences the intention of the committees to make this another war convention. Every member within reasonable distance of Worcester should make it his business to be present.

TENTATIVE PROGRAM

TUESDAY, JUNE 4

Afternoon: (Hotel Bancroft)
Registering of Members and Guests at Society Headquarters

Evening: (Hotel Bancroft)
Address of Welcome, followed by Reception and Dance

WEDNESDAY, JUNE 5

NEW ENGLAND DAY

Morning: (Worcester Polytechnic Institute)
Business Meeting
First New England Session, with opening address by Mr. Charles Washburn on the Industries of Worcester. Buffet lunch served at the Institute. During the morning and afternoon sessions it is proposed also to discuss the Textile Industry in Relation to the War; the Shipbuilding Industry; and the Manufacture of Small Arms and Gun Carriages, with reference to these industries as developed in New England

Afternoon: (Hotel Bancroft)
Second New England Session
General Session with technical papers
Industrial Safety and Workmen's Compensation Session

Evening: (Hotel Bancroft)
General War Session. The general theme of this evening session will be How the Engineering Societies Can Assist in the Procurement Program of the Government. Some major topics to be discussed are: Ordnance and Ships for the Navy Department; Munitions for the Army; Aircraft Material; Merchant Ships; Training of Labor, etc.

THURSDAY, JUNE 6

Morning: (Worcester Polytechnic Institute)
General Session with technical papers
Fuel Session
Public Relations Session

Afternoon: (Norton Company's Plant)
Luncheon
Inspection of the Norton Company's community housing and garden projects

Evening: (Worcester Country Club)
Dinner
Illustrated Lecture

FRIDAY, JUNE 7

Morning: Automobile Trip to Camp Devens, via Clinton Dam
Lunch at Camp Devens

Afternoon: Auto Trip to Concord, Lexington and return via the Wayside Inn
Afternoon tea at the Wayside Inn

dent and Secretary were summoned to Washington to approve, so to speak, the applications by one of the Departments, of suggestions made by the Society at its Annual Meeting.

One of the problems of the war is that of developing the necessary skilled labor, and it was suggested by one of the boards at Washington that this could be accomplished by converting the schools of higher technical education into trade schools, and, for a period of five months, commencing May 1, to absolutely stop all higher technical education. Our Council vigorously protested. We are pleased to report that the imminence of such a drastic action as shutting down the schools of higher technical education has, for the present, disappeared; and that the consideration of the whole subject is now in the hands of the Committee on Education and Special Training, the membership of which is made up from leading officers of the Army in its several bureaus, civilian representatives of the U. S. Bureau of Education, the engineering colleges, trade schools, corporation schools, and the Vocational Board; and a committee of this Society has been appointed, of which Prof. R. H. Fernald is chairman, consisting of Mr. F. A. Geier, Prof. Arthur L. Williston, Dean Herman Schneider, and Dr. C. R. Mann. It is the intention of this committee to assist the Government in the development of the nation's resources for the training of men without curtailing the steady flow of professional men. Recent addresses by the Secretaries of the Navy and of War have emphasized the necessity of maintaining at the highest rate the production of technically trained men, and they have appealed to the parents of the boys of the nation to send their sons to technical colleges.

Our Committee on Engineering Resources, of which Mr. George J. Foran is chairman, has lost, through the demands for personal service at Washington, Major J. H. Barr and Mr. A. D. Blake, and these vacancies have been filled by the appointment of Mr. Herman Greul and Mr. F. H. Colvin. The other members of the committee are Mr. Henry C. Meyer, Jr., and Prof. C. M. Allen, of Worcester. A most remarkable achievement has been made, and a special report on this will appear next month. This service is not only for the purpose of furnishing specialists for all demands of the Government, but to furnish specialists to the industries both during the period of the war and afterward.

The Committee on Gages, also a result of a suggestion of our Semi-Annual Meeting, has secured a substantial beginning of the movement to have departments of the Government have their gages certified in one place, namely, the Bureau of Standards, in distinction from having independent sources of authority with obvious possible differences, causing lack of interchangeability of completed parts.

The Committee on Fuel Conservation, of which Professor Breckenridge is chairman, has been very active, and, through Mr. David Moffat Myers, of the committee, who has, by virtue of the committee's activity, been invited by Dr. Garfield to be on his personal staff as technical adviser, is getting out a series of brochures on fuel conservation. Mr. F. R. Low, Editor of *Power*, and speaking for the McGraw-Hill Company, has tendered the patriotic services of members of the editorial staffs of the several publications of that company.

We have also furnished the Fuel Administrator, through Mr. Myers, with the names of our prominent members familiar with fuel economy in each of the states of the Union, and it is the Fuel Administrator's expectation to inform the state fuel administrators of the names of these experts, with the suggestion that the state fuel administrators avail themselves of technical advice.

It is evident from the way matters are managed throughout the United States, that the engineer is not yet the obvious man to do engineering work. By virtue of the fact that members of the other professions, particularly of the legal profession, have apparently made greater efforts to render public service, they are more frequently called to public office. Therefore, when and even before the invitation comes to any engineer to render services it should be expected that it will be at personal sacrifice. Such sacrifice should be made as a means of advancing our country's cause, and the standing of one's profession.

There is one activity which the Society might well undertake: namely, that of conserving those industries which have been dislocated, and, in some cases, actually put out of business by the war—as a type, the jewelry industry. There is a vast industry, with numerous skilled workers, especially fitted for certain classes of work. There seems to be no agency yet developed in the Government for foreseeing such disaster and arranging in advance that the organizations of these so-called non-essential industries shall be held together by the placing in these industries of Government work and which can be performed with comparatively slight readjustment.

At the Spring Meeting in Cincinnati the convention voted that it was the duty of all patriotic citizens to exchange data so that there would be the freest opportunity for all manufacturers to undertake work. The committee appointed at that time has suffered through the loss of some of its members in active service in the war, and at the last Council meeting a new committee was appointed, and it is hoped that they will be able to take up in addition to the technical features of such a work the broader conservation of industries as a stabilizing element of the nation so essential while at war.

The Secretary could enumerate numerous undertakings which the Society could take up with advantage, and solicits the membership to offer their services to serve on committees and make the sacrifices of time and money to carry out this service for the profession and for their country.

CALVIN W. RICE,
Secretary.

Nominations for Officers of the Am.Soc.M.E.

FOR ELECTION IN DECEMBER 1918

The Constitution of the Society in C 47 provides among the Annual Committees:

"A Nominating Committee appointed by the President."

It further provides in C 48:

A "Special Nominating Committee: Twenty or more persons entitled to vote may constitute themselves a Special Nominating Committee, with the same powers as the Annual Nominating Committee."

The procedure in the nominations for office is provided in the following By-Laws:

B 27 A Nominating Committee of five members, not members of the Council, shall be appointed before February first of each year by the President. The Secretary shall publish the names of this Committee in the March issue of THE JOURNAL, together with a request to the voting membership of the Society that they recommend to the Committee the names of eligible persons for the elective offices to be filled at the next election. This Committee shall deliver to the Secretary in writing between the first and the fifteenth of June the names of its nominees for the various elective offices next falling vacant under the Constitution, together with the written con-

sent of each nominee. The names of the nominees for the various offices proposed by this Committee shall be published by the Secretary under the names of the Committee in the July issue of THE JOURNAL.

B 28. A special Nominating Committee, if organized, shall on or before October fifteenth, present to the Secretary the names of its nominees for the elective offices next falling vacant under the Constitution, together with the written consent of each nominee. The names of the nominees for the various offices proposed by this Committee shall be published by the Secretary under the names of this Committee in the November issue of THE JOURNAL.

There are to be elected in December next

A President to hold office for one year
Three Vice-Presidents to hold office for two years
Three Managers to hold office for three years
A Treasurer to hold office for one year

The President, Charles T. Main, has appointed the following Nominating Committee for these officers:

George R. Wadleigh, of St. Louis, Mo.
William P. Caine, of Ensley, Ala.
C. F. Hirshfeld, of Detroit, Mich.
L. P. Breckenridge, of New Haven, Conn.
Thomas E. Durban, of Erie, Pa.

These names were selected by the following Sections, grouped geographically, and accepted by the President:

GROUP 1 Minnesota, Los Angeles, St. Louis and San Francisco
GROUP 2 Atlanta, Baltimore, Birmingham, Cincinnati and New Orleans
GROUP 3 Chicago, Detroit, Indianapolis and Milwaukee
GROUP 4 Boston, Connecticut, New York and Worcester
GROUP 5 Buffalo, Erie, Philadelphia and Ontario

This Nominating Committee is to meet at the Spring Meeting of the Society in Worcester, Mass., June 4 to 7, and would be pleased to receive suggestions from the membership.

Under the terms of By-Laws B 27 and B 28 the voting membership are requested to send the Nominating Committee or Committees, in care of the Secretary, 29 West 39th Street, New York, N. Y., their recommendations of names for any or all of the elective offices to be filled at the next election.

These recommendations should be sent in early and not later than June 1.

Engineers in Government Service

THE engineering societies have during the past few months supplied to various Government departments, in response to their individual requests, several thousands of names of engineers from which men have been selected to fill a great variety of positions in uniformed and civilian service for the Army and Navy and other branches of the Government's activities in connection with the war, as well as for indirect service for manufacturers and contractors engaged in war work. This service is about to be turned over to the Engineering Council, which will hereafter conduct the work through its American Engineering Service Committee.

To meet the demands the American Engineering Service Committee will assemble in its offices in the Engineering Societies Building the extensive lists and detailed information collated by the societies. The contribution from our Society is the card index compiled by the Committee on Engineering Resources, Mr. George J. Foran, Chairman, from the Personal Classification Sheets sent in by the members.

The American Engineering Service Committee desires to take this opportunity of calling attention to the fact that if these lists are to be maintained in the most useful condition to the Government and to the Engineering Council, the committee should receive promptly information concerning each engineer who has *gone into any kind of Government service*, direct or indirect, so that a record may be made on his cards in the committee's office. Members of this Society to whom this request applies are urged to send at once, if they have not already done so, their names, present addresses and occupations in the Government service, with a brief statement as to whether or not they are available for other service. This notification should be made to the Secretary, Mr. Calvin W. Rice, who will forward the information to the American Engineering Service Committee.

Certification of Gages

THE following letter will interest those who cooperated in the steps inaugurated by the Society at its Spring Meeting in Cincinnati, May 1917, to bring about the certification of gages. These steps were reported in the January issue of THE JOURNAL under the heading: Public Meeting of Gage Committee. The negotiations of the Society with the Government in the consummation of this important work were of the most pleasant character, and the Society deems it a special privilege to have been of service in the matter.

NAVY DEPARTMENT

BUREAU OF CONSTRUCTION AND REPAIR

WASHINGTON, D. C.

TO THE COMMANDANTS AND INDUSTRIAL MANAGERS OF NAVY YARDS AND NAVAL STATIONS, SUPERINTENDING CONSTRUCTORS, ETC.

Subject: Standardization of Gages

1 The Bureau of Construction and Repair designates the Bureau of Standards of the Department of Commerce, Washington, D. C., as the place at which all master and reference gages and standards of measurements are to be certified. This is intended to include all such master and reference gages and standards of measurement as are used for the work coming under the cognizance of the Bureau, both in manufacturing and inspecting.

2 All master and reference gages and standards of measurement used by private manufacturers in carrying out contracts for the Bureau, where certification is called for by the contract, shall be certified by the Bureau of Standards.

3 Where contracts are entered into which require the certification of gages, the following clause should be included in the contract:

> The master and reference gages and standards of measurements, with which are to be compared the gages and measuring instruments used in carrying out this contract, are to be certified by the Bureau of Standards of the Department of Commerce, Washington, D. C.

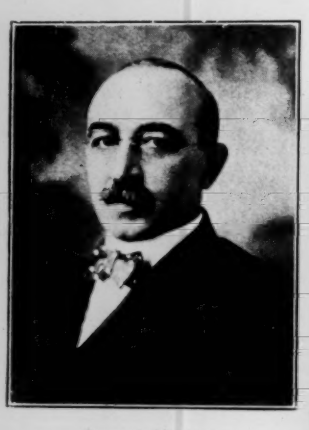
4 The designation of the Bureau of Standards as indicated above, and the adoption of the clause to be included in contracts where applicable, have been made on the recommendation of the Joint Committee appointed by The American Society of Mechanical Engineers and the Society of Automotive Engineers, with the view of the standardization of practice of the various Departments and Bureaus of the Government.

TAYLOR.

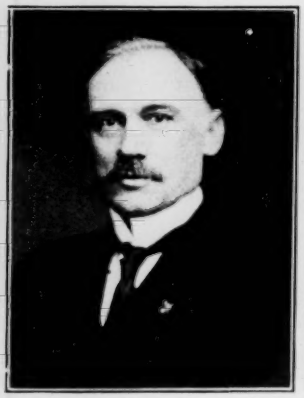
The 1918 issue of the Year Book of the Society is now off the press and will be issued at an early date.

OUR LOCAL SECTIONS ORGANIZATION:

1917-



OSCAR ELSAS
Atlanta



W. W. VARNEY
Baltimore

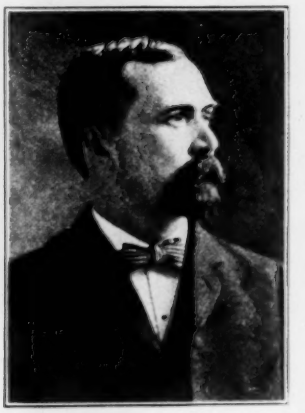
J. H. KLINCK
Birmingham

H. C. ASHTON
Boston

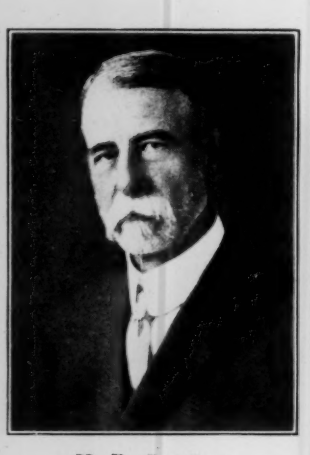
H. E. HARRIS
Bridgeport

FORREST E. CARDULLO
Buffalo

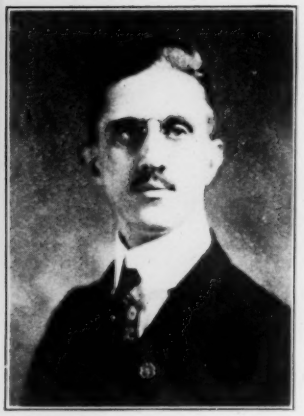
A. D. BAILEY
Chicago



G. W. GALBRAITH
Cincinnati

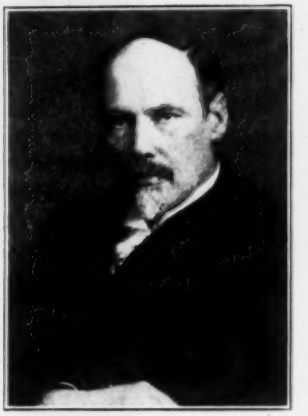


H. B. SARGENT
Connecticut



J. F. WADSWORTH
Erie

G. W. BISSELL
Detroit

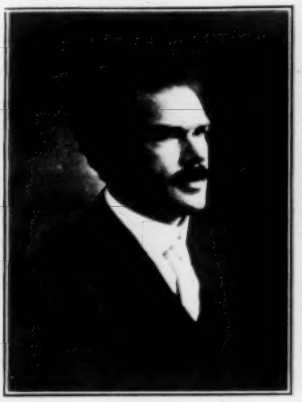


B. M. HANSEN
Hartford

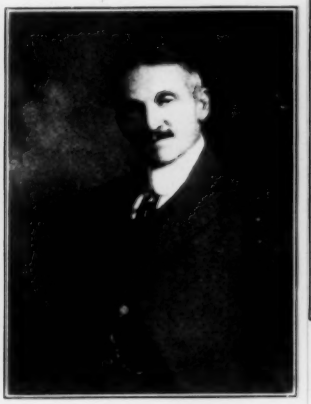
CHAIRMEN OF LOCAL COMMITTEES

1918

W. H. Insley
Indianapolis



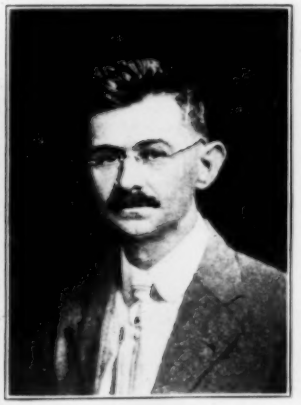
E. G. Pease
Los Angeles



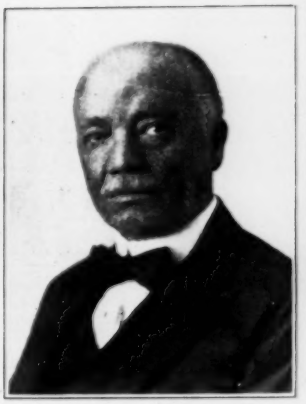
C. K. Decherd
Meriden

H. L. Brink
Minnesota

W. M. White
Milwaukee



H. L. Hutson
New Orleans



J. H. Norris
New York

R. W. Angus
Ontario

L. F. Moody
Philadelphia

B. F. Raber
San Francisco

R. L. Radcliffe
St. Louis

G. I. Rockwood
Worcester

Appeal from Navy Department

THE Navy is still in urgent need of binoculars, field glasses, spy-glasses and telescopes. The submarine has so changed naval warfare that more "Eyes" are needed on every ship, in order that a constant and efficient lookout may be maintained. Sextants and chronometers are also urgently required. Heretofore, the United States has been obliged to rely almost entirely upon foreign countries for its supply of such articles. These channels of supply are now closed, and as no stock is on hand in this country to meet the present emergency, it has become necessary to appeal to the patriotism of private owners, to furnish "Eyes for the Navy."

Several weeks ago an appeal was made through the daily press, resulting in the receipt of over 3000 glasses of various kinds, the great majority of which has proven satisfactory for naval use. This number, however, is wholly insufficient, and the Navy needs many thousands more. May I, therefore, ask your cooperation with the Navy, to impress upon your members by announcing the following salient features in connection with the Navy's call:

All articles should be securely tagged giving the name and address of the donor, and forwarded by mail or express to the Hon. Franklin D. Roosevelt, Assistant Secretary of the Navy, care of Naval Observatory, Washington, D. C., so that they may be acknowledged by him.

Articles not suitable for naval use will be returned to the sender. Those accepted will be keyed, so that the name and address of the donor will be permanently recorded at the Navy Department, and every effort will be made to return them, with added historic interest, at the termination of the war. It is, of course, impossible to guarantee them against damage or loss.

FRANKLIN D. ROOSEVELT,
Assistant Secretary of the Navy.

Navy Department, Washington, D. C.

AMONG THE LOCAL SECTIONS

SOME few months ago the Committee on Local Sections discussed ways and means for coördinating the work of the Sections with that of the Meetings and Publications Committees of the Society, with a view to developing the contributions from the Sections to the general meetings and to the publications. As the outcome the Sections Committee suggested to each Section the desirability of appointing sub-committees on papers and on research, to devote special attention to the securing of local papers for Sections which would be available for publication by the Society and to the collection of data regarding local research work in the educational institutions and the industries. To date nine Sections have responded by the appointment of these special sub-committees—Atlanta, Baltimore, Birmingham, Boston, Philadelphia, Los Angeles, New Orleans, St. Louis and San Francisco. As soon as all the Sections are heard from, the full personnel of these sub-committees will be published in THE JOURNAL.

In giving out this suggestion to the Executive Committees, the Committee on Sections realized, of course, that some Sections would probably not find it feasible to secure the results desired in just this way, in which case it left it is a matter for the Executive Committee itself to decide on what plan shall be followed. The main object desired, however, is that each Section shall contribute its share, through the general meetings and the publications of the parent Society, to the benefit of all the other Sections and of the membership generally. One of the mainstays of success of the Society is this idea of mutual service, and our organization is very fortunate in that we have a goodly number of members who derive genuine pleasure from giving a little more than they receive.

SECTION MEETINGS

BUFFALO

February 6. At a meeting of the Buffalo Engineering Society and the Buffalo Section of the Society of Automobile Engineers, C. C. Carpenter, Chief Chemist of the United States Light & Heat Co., of Niagara Falls, presented a paper on Electric Storage Batteries, in which he described the construction of the battery, the care it should receive, and the service to be expected of it. He demonstrated by means of diagrams the effect of extremely hot and cold weather on the efficiency of the battery.

February 13. At the fifth general meeting of the Engineering Society of Buffalo, J. E. Freeman, engineer of the Technical Division, Portland Cement Association, delivered an illustrated lecture on Concrete Boats. Mr. Freeman gave a general review of the progress in concrete-boat building from its earliest inception, described some of the interesting work under way at the present time, and discussed various problems entering into the application of reinforced concrete to such construction. He closed with an exhibition of motion pictures, showing concrete boats, both small and large.

February 19. Chairman F. E. Cardullo gave a talk on A Discussion of Manual and Technical Training.

E. B. NEIL,
Section Secretary.

BALTIMORE

January 10. At a joint meeting held under the auspices of the Baltimore Section, the Engineers' Club and the various associations of stationary engineers to discuss the subject of fuel saving, Charles H. Bromley, Mem.Am.Soc.M.E., delivered the main address on How to Get the Most Out of Coal. The speaker advocated the payment of a bonus as an inducement to firemen to do their best work and the employment of labor-union methods for engineers and firemen to enforce their demands.

Other addresses were made by prominent representatives from each of the associations.

January 29. Mr. Henry Adams, Mem.Am.Soc.M.E., presented a paper entitled Some Engineering Experiences, in which he discussed the development of heating and ventilating equipment, with particular reference to its application to public buildings. He traced the progress from the crude rule-of-thumb methods of the original builders of this equipment to the present.

A business meeting followed, at which a number of sub-committees were appointed. Among these was a committee to offer the services of the members of the Baltimore Section of the Society to the Fuel Administrator of Maryland, to assist in suggesting ways and means to improve the efficiency of burning coal.

A. G. CHRISTIE,
Section Secretary.

BOSTON

January 22. A reception-smoker was tendered to President Charles T. Main, preceded by a dinner at which many old-time friends and associates of Mr. Main were present. Short addresses were made by Professor Whipple, of the Boston Society of Civil Engineers, Mr. John R. Freeman, Past-President, Am.Soc.M.E., and Messrs. Desmond Fitzgerald, Lionel S. Marks, Dugald C. Jackson, H. S. Hale and Calvin W. Rice.

Mr. W. H. Balch, War Correspondent of the Boston *Evening Transcript*, gave a stirring address on Engineering the End of the War.

February 5. The Boston Section joined with the Boston A.I.E.E. Section at the Massachusetts Institute of Technology in a meeting at which a paper on The Modern Trend of Education was given by Prof. Walter I. Schlichter, of Columbia University. Among the prominent educators who discussed the paper were Professor Franklin, of Lehigh University; Professor Brozel, of Yale University, and Professor Clifford, of Masachusetts Institute of Technology. The special problems in training for the Army and Navy, as well as for the mercantile marine, munition factories and other industries directly concerned in the prosecution of the war, were covered. Reference was particularly made to the utilization of existing technical schools in New England for the production of a large number of trained men for this purpose.

W. G. STARKWEATHER,
Section Secretary.

CONNECTICUT SECTION
Hartford Branch

February 12. Chairman B. M. W. Hanson gave an interesting talk on The Functioning and Production of Automatic Fire Arms, in which he explained the composition and working qualities of the Vickers machine gun produced at the Colt's Patent Fire Arms Manufacturing Company. He described the method of insuring interchangeability of parts. He also described the method of ascertaining that the limits for tolerances were not so great as to interfere with the functioning of the gun, which method is understood to be new as far as gun manufacture is concerned. Three models are made, one accurately to maximum limits, one accurately to minimum limits and the third to mean dimensions. The parts of these three models are mixed together, and then picked out again indiscriminately to assemble a gun. This gun is tested in every conceivable manner, and it is easily determined whether the results for tolerance are too great in any particular case.

Mr. Hanson was assisted by Mr. Fred T. Moore, the ballistic expert of the Colt Company, who gave an interesting explanation of the functioning of the Vickers gun.

S. F. JETER,
Section Secretary.

CONNECTICUT SECTION
Meriden Branch

January 17. Professor L. P. Breckenridge, Mem.Am.Soc.M.E. delivered a talk on Coal Conservation. As a result of an invitation extended to the factory owners and the engineers and firemen of the town, there were over 250 persons present. It was a meeting which proved that the Branch could be of valuable service to the community.

February 14. Sixty persons attended the meeting on this date, at which Mr. C. E. Rigby, Engineer for the Blackstone Mutual Fire Insurance Company, gave an illustrated lecture on Fire Protection in Manufacturing Plants.

CHARLES N. FLAGG,
Section Secretary.

LOS ANGELES

February 7. Mr. L. D. Gilbert, Mem.Am.Soc.M.E., delivered an illustrated lecture on The Practical Side of Portland Cement Manufacture, in which he described fully the construction and operation of the South-Western Portland Cement Company's plant located at Victorville, Cal.

T. J. ROYER,
Section Secretary.

MILWAUKEE

January 16. Mr. Walter Alexander, Superintendent of Motive Power for the C. M. & St. P. Ry. Co., gave an illustrated lecture on Electric Locomotives on this railroad.

February 13. Mr. E. S. H. Baars, of the Vilter Manufacturing Co., gave an illustrated talk on Cold Accumulators and Their Application to the Refrigerating Industry.

An illustrated address on The Refrigerating Equipments at the United States Army Cantonments was given by Messrs. Alex H. Luedicke and Fred Goes, also of the Vilter Company.

FRED H. DORNER,
Section Secretary.

NEW ORLEANS

January 14. The A.S.M.E. Section participated in an enjoyable smoker held in connection with the Annual Meeting of the Louisiana Engineering Society.

February 11. By invitation, the New Orleans Section participated in the meeting of the Louisiana Engineering Society, at which a paper on Some Notes on Wireless Telegraphy was read by Prof. P. E. Lehde.

E. W. CARR,
Section Secretary.

ONTARIO

January 29. At a meeting held at Toronto, Mr. F. B. Ward, of the John Inglis Company, gave an address on The Influence of Munition Manufacture and Other War Work on Machine Shop Practice. Several prominent members of the Section took part in the discussion.

CHESTER B. HAMILTON, Jr.,
Section Secretary.

PHILADELPHIA

February 26. Mr. Carl G. Barth, Mem.Am.Soc.M.E., appeared in a somewhat novel rôle, with a paper on the Income Tax, in which, by a thorough mathematical analysis of the Federal Income Tax Law represented graphically in several ways, he clearly set forth the defects of this law. Mr. Barth showed conclusively that if the rates imposed on incomes up to about $10,000 and above $40,000 are at all fair, then the rates imposed between these two limits are decidedly too high, as recognized and partially corrected in the recent amendment offered by Senator Smoot. He also showed that an exemption for any income, however small, is a mathematical absurdity. Theoretically every income should be taxed, but if this is done consistently a tax too small to make it worth while to collect it is yielded. There must therefore be a natural exemption for incomes below a certain point, as provided by the recent legislation.

It is always a matter of interest to note the applications by engineers of some of their principles to the broader problems of life, and, strange to say, it is by such studies that the engineer often receives a greater public recognition. Taylor's work, for instance, is best known in its psychological aspects. Mr. Barth's discussion of the income tax calls to mind that Mr. Hugo Bilgram, another of our prominent Philadelphia engineers, and a man who is usually associated with machine construction, has devoted many years of study to problems of economics, especially causes of and cures for panics.

JOHN P. MUDD,
Section Secretary.

PROVIDENCE

January 2. Mr. Frederick J. Hoxie, Mem.Am.Soc.M.E., delivered an illustrated lecture on the Causes of Rot in Timber.

February 20. An illustrated lecture on Water Power Development in New England was given by Henry I. Harriman, of Chace & Harriman, Boston. Mr. Harriman was largely instrumental in the development of the Connecticut River Power Company and of the New England Power Company, and is therefore well qualified to discuss this subject. Some of the largest hydroelectric plants in the six states east of the Hudson and also in some of the western states were described fully, and the various types of construction used in developing and utilizing water power were illustrated.

Several other meetings were held during the month by the various sections of the Providence Engineering Society.

JAMES A. HALL,
Correspondent.

ST. LOUIS

February 8. Mr. C. B. Lord, Mem.Am.Soc.M.E., delivered a lecture on the Manufacture and Use of Ammunition as Adapted to Present-Day Warfare. Through the courtesy of the Wagner Electric & Manufacturing Company, he exhibited a number of samples of explosives and shells, and described the methods of

their manufacture, as well as their use in the present war. Mr. Lord's talk also covered fully the manufacture and use of large guns, submarines, torpedoes and depth bombs.

E. H. TENNEY,
Section Secretary.

Student Branch Meetings

BUCKNELL UNIVERSITY

February 4. Following a business meeting, Mr. Fred Bauman gave an interesting talk on The Efficiency Engineer.

H. R. PARS,
Branch Secretary.

LEHIGH UNIVERSITY

February 7. A paper on Recent Developments in Artillery was given by J. W. Hogg, '18, in which he described the French low-power and the German high-power guns.

Mr. Boyd E. Keifer, '18, presented a paper on Modern Milling Machine Cutters, in which he described the new form of milling cutter which has been found very successful by the Bethlehem Steel Company. Instead of using the old form with radial teeth the new type has undercut teeth; the tooth profile does not pass through the center of the cutter but back of it. The old form pushes the metal down, while the new type actually cuts it. The new type removes 67 per cent more metal and runs 75 per cent faster than the old type.

N. DMYTROW, JR.,
Branch Secretary.

OHIO STATE UNIVERSITY

January 15. The following officers were elected: Paul Bucher, chairman; H. R. Ansel, vice-chairman; F. E. Smyser, secretary; C. L. Smith, treasurer, and A. A. Casey, sergeant-at-arms. Mr. R. L. Dickinson, Industrial Service Secretary of the Columbus Y.M.C.A., gave a talk on the work being done by the engineer and manufacturer among aliens in Columbus. The Secretary presented a report of the Conference of Student Branches at the Annual Meeting.

F. E. SMYSER,
Branch Secretary.

GEORGIA AGRICULTURAL COLLEGE

January 23. Following a short business meeting the following papers were presented: The Hydraulic Ram, by E. W. Dye; Impulse and Reaction Turbines, by George Carpenter; Hydraulic Engines, by Professor Graf; and Types of Rams, by Professor Goldman.

NEAL K. FORD,
Branch Secretary, pro tem.

PENNSYLVANIA STATE COLLEGE

January 22. The following officers for the second semester were elected: F. R. Hoffman, chairman; Mr. Smith, vice-chairman, H. C. Wright, secretary.

Following a short talk by Professor Wood, each member present was presented with a copy of the thesis by H. R. Hammond and C. W. Holmberg which was awarded the Student Prize at the Annual Meeting of the A.S.M.E.

The following resolutions were passed regarding the death of H. R. Hammond, one of the authors of the thesis:

WHEREAS; In the untimely death of H. R. Hammond of the class of 1916, we have lost an active and faithful member of our society, be it

RESOLVED; That we express our highest appreciation of his unselfish and active services in the interests of our society while in college, and especially to record the honor which has come to our local branch because of the work of merit which was recently presented by Messrs. Hammond and Holmberg and which won the coveted prize for the best paper submitted by members of the Student Branches throughout the country, and which was later read at the Annual Meeting of the A.S.M.E. Also be it resolved, as a further mark of our esteem for his excellent character, that these resolutions be spread upon the minutes of the society and a copy be sent to members of his immediate family.

HAROLD C. WRIGHT,
Branch Secretary.

PURDUE UNIVERSITY

January 15. Mr. J. E. Hannum, instructor in mechanical engineering, gave a talk on The Mechanical Features of the Submarine. The two types of undersea vessels, the submarine and the submersible or modern U-boat, were described and their design and construction explained by means of sketches.

CLAUDE S. KEGERREIS,
Branch Secretary.

STEVENS INSTITUTE OF TECHNOLOGY

February 5. Prof. R. M. Anderson, successor to Dr. Alexander C. Humphreys as Honorary Chairman of the Branch, gave an interesting talk on The Future of the Society. Following the talk the Inspection Trip Committee reported that trips had been arranged to visit the Cooper Hewitt and the Colgate Works.

The proposed new constitution for the Stevens Engineering Society was submitted to those present for consideration and will be considered at the next meeting.

LINCOLN V. AQUADRO,
Branch Secretary.

THROOP COLLEGE OF TECHNOLOGY

February 1. At a joint meeting of the Student Branches of the A.S.M.E. and A.I.E.E., Prof. H. Adams delivered a lecture on Engineering in China. Professor Adams lived in China for a number of years and was therefore well qualified to speak on the subject.

RETLA ALTER,
Branch Secretary.

TUFTS COLLEGE

January 23. Mr. M. W. Hogdon, '18, gave an illustrated talk on Aviation and Aeroplanes, in which he described the methods of training aviators in this country and in Europe. He also spoke of the tactics employed by skilled airmen in battling with a foe, the causes of accidents, and the great strides made in increasing the safety of flying.

CHRISTOPHER I. SMITH,
Branch Secretary.

UNIVERSITY OF CALIFORNIA

February 11. A business meeting was held, at which the following officers were elected: F. C. Holman, chairman; E. K. Schulze, vice-chairman; L. M. K. Boelter, secretary, and H. L. Reich, treasurer.

LLEWELLYN BOELTER,
Branch Secretary.

UNIVERSITY OF CINCINNATI

February 1. Mr. E. W. Roberts, a Cincinnati aeroplane expert, delivered an illustrated lecture on The History of Flight, describing in detail one of the early types of balloons and other flying contrivances. One of the first English aeroplanes (built by Hiram Maxim) the speaker assisted in building, and he told many interesting facts about its construction, comparing it with the more modern machines.

C. L. KOEHLER,
Branch Secretary.

UNIVERSITY OF COLORADO

February 7. At a meeting of the combined branches, an interesting talk was given on Explosives by Mr. Skinner, General Manager of the Western Chemical Works. A division of the R.O.T.C. has been organized at the University and practically every member of the Branch has joined.

H. O. CROFT,
Branch Secretary.

UNIVERSITY OF ILLINOIS

In the early part of the college year the Student Branch, representing the Mechanical Engineering Department, gave a very instructive Mechanical Engineering Show.

At the second meeting of the Branch, Mr. Godeke, instructor in mechanical engineering, delivered a lecture on Equipment of the Power Laboratory. Opportunities in connection with the Student Branch were discussed by Mr. Radebaugh.

The subject of the November meeting was Airplane Engines, the speaker being Capt. L. Simpson of the School of Military Aeronautics.

At the December Meeting, Mr. B. S. Day, instructor in the power laboratory, spoke on Our Laboratory, Old and New. The Branch also held a smoker during the month which was well attended.

J. J. KALIVODA,
Branch Secretary.

UNIVERSITY OF MISSOURI

January 15. A paper was presented by L. N. Thompson on Recent Developments in the Design of Aeroplane Engines.

J. W. BALDWIN,
Branch Secretary.

UNIVERSITY OF NEBRASKA

February 5. The Diesel Engine was the subject of the meeting and was discussed in a paper by Mr. F. W. Rabe, who spent some time in Germany before the war and had inspected several of the Diesel factories. In addition to bringing out the advantages and disadvantages of the Diesel engine, Mr. Rabe also spoke about the life of the inventor and the many obstacles he encountered in selling his patents.

Professor Seaton brought out a fact of interest that the Germans have perfected a Diesel engine actually light enough to be of practical use as a prime mover for aeroplanes.

W. L. MILLAR,
Branch Secretary.

UNIVERSITY OF OKLAHOMA

January 15. At a joint meeting of the A.I.E.E. and A.S.M.E. Branches the following papers were presented: The Electron, by Professor Tappen; Large Types of Steam Boilers, by Professor Helmrick—of especial interest since the speaker had recently returned from Detroit where the largest boiler of today is located; Some Large Power Plants in New York, by Dean Felgar; and Frequencies, by L. B. Holland.

PAUL B. STOCKWELL,
Branch Secretary.

UNIVERSITY OF WASHINGTON

The university is coöperating with the Government by having a Reserve Officers' Training Corps in which underclassmen receive eight hours of training a week with upperclassmen as officers and members of the faculty as instructors, the latter being in the R.O.T.C. An A.U.S. Naval Training Station is located on the campus with an enrollment of about a thousand and a course for marine operating engineers under the direction of the U. S. Shipping Board is given by the mechanical engineering faculty to men from all over the West and Southwest. Over a thousand men from the University of Washington are now in the service, and a good share from the engineering school are now in various branches of the Engineering Corps and other branches of service.

January 17. The meeting was held to discuss plans for a smoker. It was also voted to procure a service flag for the Mechanical Engineering Department at the University.

February 6. Wooden Ship Building and Development, and the Use of the Semi-Diesel Engine in Wooden Ships was the subject on which Mr. R. M. Dyer, Mem.Am.Soc.M.E., gave a most interesting talk. The Diesel Engine was also discussed by Mr. J. M. Royal, Jun.Am.Soc.M.E.

Mr. Anderson, of The American Blower Company, made an address on the Value of a College Education.

H. B. SALLEE,
Corresponding Secretary.

UNIVERSITY OF WISCONSIN

January 24. The following were elected officers for the second semester: George Moore, chairman; Glenn Warren, vice-chairman; W. Mantonya, secretary, and K. Seelback, treasurer. An amendment was made to the Student Branch Constitution whereby a fine would be imposed upon the members for absence from a meeting.

K. G. SHIELS,
Branch Secretary.

VIRGINIA POLYTECHNIC INSTITUTE

January 24. The meeting was devoted entirely to business matters, including planning the conduct of future meetings and the election of C. H. Driskill as chairman, to succeed Mr. Kearsley.

E. W. DIGGES,
Branch Secretary.

WORCESTER POLYTECHNIC INSTITUTE

January 11. At the Joint Meeting of the Student Engineering Societies, held under the auspices of the Civil Engineering Society, S. G. Webb, engineer with the Gypsum Industry Association, gave an interesting and valuable talk on the Use of Gypsum in Building Construction. He first explained what gypsum was from the chemist's viewpoint, calling attention to its commonly used name in the arts of plaster of paris and in its use in agriculture under the name of plaster, and then described the sources from which it is procured, its manufacture and finally its use in the building trades. Interesting points brought out were the adaptability of this material to construction of all sorts, its great fire-resisting qualities, its low sound-transmitting quality and its use as a heat-insulating material.

February 6. The resignation of Chairman R. C. Lewis was accepted, owing to his enlistment in aviation work. Mr. Chenoweth Housum, Engineer for the Jefferies-Norton Company, gave a talk on Some Large Gas-Engine Installations, reviewing the merits of the two- and four-cycle types of gas engines. The fuels used in large gas engines such as natural gas, coke-oven gas, blast-furnace gas and producer gas were considered in detail and problems to be overcome in using these fuels were cited. The advantages gained by the use of gas engines over steam engines for blowing in steel mills and blast-furnace work were also touched upon.

H. P. FAIRFIELD,
Branch Secretary.

The Association of Eleventh Engineers (Ry.) has been formed to promote the welfare of the 11th Engineers (Ry.), U. S. A.

This regiment is the one which was recruited entirely by the Military Engineering Committee of the Engineering Societies. The regiment was in the fighting at Cambrai, where it gained the prompt praise of both British and French generals, and earned the name of "The Fighting Engineers."

The Association will be glad to receive from engineers, contributions for carrying on its manifold aims and activities, all of which center to the underlying purpose of service to the men of the 11th Engineers. Mr. J. Waldo Smith, Mem.Am.Soc.M.E., is chairman of the Finance Committee and Mr. Robert Lynn Cox is treasurer, to whom contributions should be sent at the Metropolitan Life Building, No. 1 Madison Ave., New York City.

SIR JOHN WOLFE WOLFE-BARRY, one who, by his most varied ability, wide experience, sound judgment and untiring energy, represented the highest traditions of the engineering profession, died on January 22 in his eighty-second year. Sir John will perhaps best be remembered by the engineering societies in this country for his valuable work in connection with the British Engineering Standards Committee. This work inspired the standardization movement among the engineering societies here, which led to the establishment of the American Engineering Standards Committee. This committee now aspires to do the same valuable work for American engineering that the British committee has done for British practice.

Those members of the Society who are interested in this standards work would do well to refer to Sir John's lecture on The Standardization of Engineering Materials and Its Influence Upon the Prosperity of the Country, delivered as the James Forrest Lecture before the Institution of Civil Engineers in 1917, and published in London *Engineering*, vol. ciii, p. 432. His lecture contains a great mass of valuable and interesting information.

NINTH ROLL OF HONOR

MEMBERS of the Society can note with pride how our Roll of Honor is steadily lengthening—this in spite of the fact that the everyday work of a large number of the members is a patriotic service in itself. The call to arms appears to be irresistible and the response unhesitating:

ALEXANDER, W. P., Captain, Inspection Division, Ordnance Department, United States Army.

ALLEN, HENRY A., Colonel Commanding 108th Engineers, 33rd Division, Camp Logan, Houston, Tex.

ANDERSON, F. C., Captain, Engineers' Reserve Corps, Metuchen, N. J.

ATTERBURY, W. W., Brigadier-General, Director General of Transportation, American Expeditionary Forces, France.

BARTON, RAYMOND L., First Lieutenant, Ordnance Officers' Reserve Corps, United States Army.

BEEN, PAUL, Corporal, 9th Engineer Train, Courchesne Bridge, El Paso, Tex.

BERGES, ARTHUR H., Sergeant, First Battalion Headquarters, 23rd Engineers, American Expeditionary Forces, France.

BEVIN, SYDNEY, Captain, Ordnance Officers' Reserve Corps, Detached Service.

BLUMENFELD, R., Lieutenant, Ordnance Officers' Reserve Corps, Production Section, Carriage Division, Washington, D. C.

BORNHORST, A. H., First Lieutenant, Signal Officers' Reserve Corps.

BOOTHMAN, DALE M., First Lieutenant, Ordnance Officers' Reserve Corps, Engineering Bureau, Trench Warfare Branch, Washington, D. C.

BORDEN, JOHN M., Second Lieutenant, Ordnance Officers' Reserve Corps.

BREEDLOVE, L. B., First Lieutenant, Ordnance Officers' Reserve Corps, United States Army.

BRYAN, MARCUS K., Lieutenant, Ordnance Officers' Reserve Corps.

CHURCH, F. O., First Lieutenant, Company B, 26th Engineers, American Expeditionary Forces, France.

CLARKE, LEON L., American Expeditionary Forces, France.

COOLEY, M. E., Lieutenant Commander, Michigan Naval Brigade, Ann Arbor, Mich.

COOPER, HUGH L., Major, Engineer Officers' Reserve Corps, American Expeditionary Forces, France.

CORY, HARRY THOMAS, Major, Engineer Officers' Reserve Corps (unassigned).

CROSBY, W. W., Lieutenant-Colonel, 104th Engineers, Camp McClellan, Ala.

CULLEN, JAMES W., Signal Corps, United States Army.

DAVIES, T. R., First Lieutenant, Ordnance Officers' Reserve Corps, Carriage Division, Field Artillery Section, Ordnance Department, United States Army.

DAVIS, CALVIN E., Second Lieutenant, Aviation Section, Signal Officers' Reserve Corps.

DUFFY, FRANK J., Major, 103rd Regiment of Engineers, United States Army.

DUVENECK, FRANCIS B., Master Signal Electrician, 322nd Field Signal Battalion, United States Army.

EHRHARDT, JOHN J., Captain, Ordnance Department, United States Army.

EYRE, THOMAS T., Captain Engineers, United States Reserve, Commanding Company E, 113th Engineers, Camp Shelby, Miss.

FLICKINGER, HARRISON W., First Lieutenant, Signal Officers' Reserve Corps, Aviation Section, United States Army.

FOGG, OSCAR H., Captain, Officers' Reserve Corps, United States Army.

FORTNEY, C. P., Captain, Engineers, United States Reserve, Washington, D. C.

FULLER, FLOID M., Lieutenant, Reserve Force, United States Navy.

GARRETT, SEYMOUR S., Captain, Engineer Officers' Reserve Corps (Unattached), American Expeditionary Forces, France.

GATELY, W. A., First Lieutenant, Ordnance Officers' Reserve Corps, Rock Island Arsenal, Ill.

GIEBEL, ROBERT L., Second Lieutenant, Ordnance Officers' Reserve Corps.

GRAVES, RALPH I., Captain, Field Artillery Section, Carriage Division, Ordnance Department, Ordnance Officers' Reserve Corps, United States Army.

HALL, ROLAND B., JR., Captain, Engineer Officers' Reserve Corps, France.

HAWES, ALEXANDER G., Captain, Ordnance Officers' Reserve Corps, United States Army.

HAYES, WILLIAM PARSONS, Lieutenant, Fleet Naval Reserve, assigned to U. S. S. Niagara.

HILL, REUBEN, Major, Ordnance Officers' Reserve Corps, Office of Chief of Ordnance, Washington, D. C.

HIRSHFELD, CLARENCE F., Major, Ordnance Officers' Reserve Corps, United States Army.

HOFFMAN, ROSCOE C., Captain, Ordnance Officers' Reserve Corps, Motor Equipment Section, Carriage Division, Washington, D. C.

HUNTER, HERBERT C., First Lieutenant, Trench Warfare Branch, Engineering Bureau, Ordnance Officers' Reserve Corps.

LEWIS, GOODRICH Q., Ensign, United States Naval Reserve Force.

LISKOW, B. H., Captain Engineers, United States Reserve.

LOCKARD, JAMES P., Second Lieutenant, 328th Field Artillery, Officers' Reserve Corps, Camp Custer, Battle Creek, Mich.

LORING, ERNEST J., Captain, Ordnance Officers' Reserve Corps, Design Section, Trench Warfare Branch, Gun Division.

LYNE, LEWIS F., JR., First Lieutenant, Ordnance Officers' Reserve Corps, Inspector of Ordnance.

MACARDELL, WESLEY E., Department of Engineers, U. S. Military Academy, West Point, N. Y.

MACEWAN, THOMAS S., Aviation Section, Signal Enlisted Reserve Corps.

MARDAGA, LOUIS, Ensign, United States Naval Reserve Force.

MARTIN, ELMER C., Engineer Officers' Training Camp, 7th Company, Camp Lee, Petersburg, Va.

MAURY, DABNEY H., Major, Engineer Officers' Reserve Corps, Office Cantonment Constructor, Washington, D. C.

MAXFIELD, HOWARD H., Lieutenant, Colonel 19th U. S. Engineers, American Expeditionary Forces, France.

MINICH, HENRY D., First Lieutenant, Ordnance Department, United States Army.

O'CONNELL, JOHN J., Captain, Ordnance Officers' Reserve Corps, United States Army.

PARK, J. FRANK, JR., 12th Engineers, Railway, H. Q. Detachment, American Expeditionary Forces, France.

PETERS, CLIFFORD H., Lieutenant, Ordnance Officers' Reserve Corps.

PICCARD, J. E., Captain, United States Army, Corozal, Canal Zone.

POHLE, R. F., First Lieutenant, Production Officer, Ordnance Officers' Reserve Corps.

PULLEN, ROYAL R., First Lieutenant, 364th Infantry, Reserve Corps, Camp Lewis, Wis.

RENTON, J. LEWIS, Captain, Company G, First Regiment Hawaiian Infantry, National Guard, Erva, Hawaii.

REUTER, FRANCIS J. G., First Lieutenant, 7th Coast Engineer Reserve Officers' Training Camp, United States Reserve.

RIDER, JOSEPH B., 2nd, Company E, 10th Engineers (Forestry), American Expeditionary Forces, France.

RITTER, E. R., First Lieutenant, Ordnance Officers' Reserve Corps.

ROLAND, P. W., Naval Aviation Corps.

RUGG, DANIEL M., 307th Engineers, United States Army.

SAGE, DARROW, Lieutenant, N. M. Y., United States Navy, U. S. S. Missouri.

SANDERS, WALTER C., Lieutenant, Coast Artillery Reserve Corps, United States Army.

SEATON, ROY A., Captain, Ordnance Officers' Reserve Corps, United States Army.

SELLMAN, NILS T., Engineer, Coast Artillery National Guards, United States Army.

SEYBOLD, EUGENE, First Lieutenant, Ordnance Officers' Reserve Corps, Watervliet Arsenal, Watervliet, N. Y.

SHATTUCK, CHARLES H., First Lieutenant, Ordnance Reserve Corps, United States Reserve.

SHUSTER, M. M., Naval Aeronautic Branch, Naval Air Station, Pensacola, Fla.

SLOAN, BEN, Captain, Ordnance Officers' Reserve Corps, Inspector of Ordnance, United States Army.

STRAUSS, JEROME, Lieutenant, Inspector of Ordnance, Ordnance Department, United States Reserve.

SWINBURNE, JAMES G., First Lieutenant, Ordnance Officers' Reserve Corps, United States Army.

UNDERHILL, CHARLES R., Captain, Aviation Section, Signal Reserve Corps.

VEHSLAGE, HAROLD E., First Lieutenant, Procurement Division, Ordnance Department, United States Army.

VOGT, CLARENCE W., First Lieutenant, Ordnance Department, U. S. R., Frankford Arsenal.

WADSWORTH, GEORGE R., Major, Engineer Officers' Reserve Corps, United States Reserve.

WANDEL, CARELTON, First Lieutenant, Ordnance Department, American Expeditionary Forces, France.

WILFERT, GEORGE, Captain, Ordnance Officers' Reserve Corps, United States Army.

WILKINS, CHARLES N., Aviation Section, Signal Enlisted Reserve Corps.

WOODS, SAMUEL H., Captain, Engineering Section, Quartermaster Corps, United States Army.

PERSONALS

IN these columns are inserted items concerning members of the Society and their professional activities. Members are always interested in the doings of their fellow-members, and the Society welcomes notes from members and concerning members for insertion in this section. All communications of personal notes should be addressed to the Secretary, and items should be received by March 16 in order to appear in the April issue.

CHANGES OF POSITION

GILBERT G. WEAVER, formerly director of the Cooperative Industrial School, York, Pa., has assumed the duties of director of the Dayton Industrial Institute, Dayton, Ohio.

H. HAMILTON WEBER has left the lubricating division of the Texas Company in New York, and has joined the efficiency department of the Hyatt Roller Bearing Company, of Newark, N. J.

JAMES A. CAMPBELL has resigned his position with the Renfrew Manufacturing Company, Adams, Mass., as mechanical superintendent, and has taken a similar position with Lever Brothers, Cambridge, Mass.

CHARLES A. HAYNES, until recently superintendent of the Mohegan Tube Works, Brooklyn, N. Y., has assumed the duties of production engineer with the British Ministry of Munitions in the United States.

JAMES BRAKES, JR., has resigned his position as power plant inspector for the Western Electric Company, Chicago, Ill., to accept the position of draftsman for the Gamm Bernstein Motor Truck Company, Lima, Ohio.

MARTIN NEWCOMER, formerly production manager of the American Player Action Company, New York, has become affiliated with the U. S. Cartridge Company, Lowell, Mass., as engineer in charge of shell waterproofing.

JOHN F. GUTHRIE, formerly associated with the Arnold Print Works, of North Adams, Mass., in the capacity of mechanical engineer, has accepted a similar position with The Abrasive Company, of Bridesburg, Philadelphia, Pa.

CARL T. CARLSON has resigned his position with the Springfield Boiler and Manufacturing Company, of Springfield, Ill., as chief engineer, and has accepted the position of combustion engineer for the City of Gothenburg, Sweden.

EARL B. MORGAN has resigned as safety engineer for the Norton Company to take the position of safety engineer with the Liberty Mutual Insurance Company, of Boston, Mass. Mr. Morgan will take up his new duties March 1.

FREDERICK W. BURGER has left the employ of the Delphos Manufacturing Company, Delphos, Ohio, to accept the position of assistant to the superintendent of the experimental department of the International Harvester Corporation, Chicago, Ill.

HAROLD E. SMOCK has resigned his position as chief draftsman of the Cohoes Rolling Mill Company, Cohoes, N. Y., subsidiary concern of the Page-Hersey Iron, Tube and Lead Company, of Toronto, Canada, to enter the Ordnance Department at Washington, D. C.

MELVIN B. NEWCOMB is no longer connected with the special engineering department of the Firestone Tire and Rubber Company, Akron, Ohio, having assumed the position of chief draftsman of the hydraulic department of the Wellman Seaver Morgan Company, Cleveland, Ohio.

JOHN H. ROMANN, until recently works engineer with the American Steel Foundries, Indiana Harbor, Ind., has become associated with the export department of J. T. Ryerson and Son, Chicago, Ill. Mr. Romann will leave for Europe in July as representative of the Ryerson Company for the Latin countries of Europe.

FREDERICK A. BARNES, for nine years with George S. Rider and Company, consulting engineers, Cleveland, Ohio, and for the past year in charge of the office, has severed his connection with that firm and is at present in Washington, in the quartermaster-general's office, engaged in the design of standardized shops for repairing military trucks.

OLIVER M. DAVIS has left the employ of Swift and Company, with whom he was connected for the past six years, giving up his position of general superintendent of oil mills, Columbia, S. C., to take up work in connection with the Government's program for the building of fabricated ships, with headquarters at the Whitehead and Kales Iron Works, Detroit, Mich.

ANNOUNCEMENTS

M. E. GOULD has become associated with the Covert Gear Company, of Lockport, N. Y.

JOHN CALDER has been made vice-president and general manager of the Aero Marine Plane and Engine Company, Keyport, N. J.

JOHN B. MATTHEWS has become affiliated with the Moore and Scott Iron Works, Oakland, Cal., in the capacity of engineer.

JOSEPH WILCOX, JR., has entered the service of the Fitchburg Grinding Machine Company, Fitchburg, Mass., in the capacity of chief draftsman.

Greetings have been received from the front from our member, P. G. WELFORD, of the Canadian Field Artillery, in the form of an attractive card issued by the Fourth Canadian Division.

LOUIS MARDAGA has entered the naval service in the capacity of Ensign, U. S. N. R. F., and is at present located as assistant naval inspector of ordnance, Alloy Steel Forging Plant, Carnegie, Pa.

JOHN C. MAHONEY, formerly connected with the General Electric Company at Atlanta, Ga., as district turbine inspector, has become associated with the Schenectady office of the same company.

CARL G. BARTH, consulting management engineer, of Philadelphia, has been given a special commission in the matter of extending costs investigation for the Watertown Arsenal, Watertown, Mass.

F. J. HULL, who was associated with the Pangborn Corporation as engineer, about five years ago, and more recently in the employ of the Mott Sand-Blast Company, has returned to the Pangborn Corporation in the capacity of assistant engineer.

FRED V. HADLEY has resigned as chief engineer of the American Incandescent Heat Company, Boston, Mass., and has opened an office in Boston, Mass., for general consulting work, specializing in heat-treatment engineering and industrial-furnace design.

ROBERT L. HIBBARD has resigned his position as assistant manager and gas engineer of the Riter-Conley Company, Pittsburgh, Pa., with which firm he was connected for the past 15 years, and has opened engineering offices in the Jenkins Arcade Building, Pittsburgh, Pa.

JOSEPH ESHERICK, of Philadelphia, Pa., has become associated with the Baker-Dunbar-Allen Company, which, under Mr. Esherick's personal supervision, will represent the D. Connelly Boiler

Company, The Foxboro Company and the Welding Instrument Company.

JOHN W. F. BENNETT, after eight years of service with the City of New York, first as deputy commissioner of water supply and later as consulting engineer, announces that he is now associated with Ernest P. Goodrich and A. Pearson Hoover, consulting engineers, with offices at 261 Broadway, New York.

CAPT. CLARENCE W. VOGT was commissioned a First Lieutenant, Ordnance Department, U. S. R., June 11, 1917, and was ordered to the Frankford Arsenal at Philadelphia, Pa., August 1. He was promoted to the grade of Captain Ordnance, U. S. N. A., January 22, 1918, and is in charge of the artillery primer shops at the Frankford Arsenal.

CHARLES S. HAMNER and HOWARD P. QUICK, who have been associated for some time in engineering inspection and appraisal work in New York, have taken over the engineering and sales

C. S. FOLLER

management of the Parson Manufacturing Company's system of fuel-burning apparatus and ash ejectors for power plants, ships and factory heating plants, with offices at 165 Broadway, New York.

L. H. BERGMAN, until recently fuel engineer for the Midvale Steel Company, Philadelphia, Pa., and J. W. Lauren, formerly vice-president of the Reynolds Wire Company, Dixon, Ill., have incorporated the American Industrial Engineering Company with offices in the Monadnock Building, Chicago, Ill., and will specialize on wire-mill equipment, pulverized-fuel installations, furnace work and fuel economy.

APPOINTMENTS

WILLIAM PARSONS HAYES has been appointed a Lieutenant in the Fleet Naval Reserve and assigned to the *U. S. S. Niagara*.

DAVID H. RAY has been appointed director of the Laboratory, U. S. Signal Corps School National Army, at the College of the City of New York.

NECROLOGY

WILLIAM L. DIERMAN

William L. Dierman was born on May 19, 1868, in Ghent, Belgium. He was educated in the College of Toulouse, France, and the College of Richmond, in London, England. In 1887 he received the degree of C.E. from Ghent University and in 1888 the degree of E.E. from the Montefiore Institute, Liège, Belgium.

Upon the completion of his engineering course he became associated with the Société Générale Electrique and was located first in Paris and afterward in Lille, France. It was while with the Société that he had charge of the building of tramways in European Russia and the Caucasus.

He was next connected with the Société Eclairage et Transmissions Electriques a Longe Distance, where his duties at first

In 1890 he was commissioned by the Belgian Government to make a report on the electric traction of the United States. In 1891 he was made supervising engineer of the electric-traction department of the Compagnie Internationale d'Electricité, Liège. He was the designer of the electric-traction system of the Liège and Herstal Street Railway and of many other minor systems. He was the supervisor of the installation of the electric system in Liège. From 1893 to 1901 he was general manager of the concern of Dierman & Co., Liège, which later became the Société des Applications de l'Electricité in Liège. In 1901 he located in Brussels, where he acted as consulting engineer for the Compagnie Générale de Construction, Paris, Ateliers Rateau Muyser-Malines, and Ateliers de Construction de Blanc Misseron, designing electrical and mechanical plants for these companies.

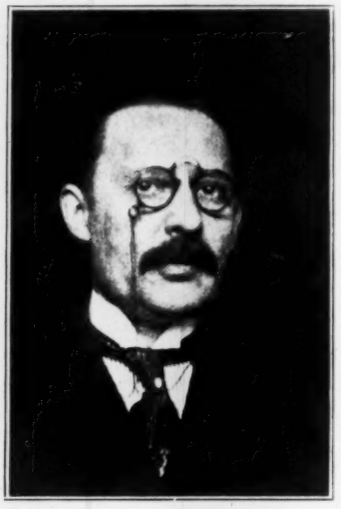
Since the war he has been purchasing manager in New York for the Eclairage Electrique of Paris. In this connection he directed the purchase of machine tools and machinery for new works in France. He was the Administrateur Delegue for Belgium of his concern. He also maintained a private office as consulting engineer in Brussels.

Mr. Dierman was a member of the Société des Ingénieurs Civils de France. He became a member of the Society in 1915. He died on December 25, 1916.

GEORGE LELAND FALES

George L. Fales was born on May 18, 1878, in Nashua, N. H., and was educated in the grammar and high schools there. His technical education he obtained through self-study.

For two years he was in charge of the power plant of the Bayley Hat Manufacturing Co., Newburyport, Mass. His next position was with the G. R. & I. St. Ry. Co., Georgetown, Mass., as chief engineer of its 1200-hp. power plant. In September 1899 he was made chief mechanical engineer of the Boston Almshouse and Hospitals, Boston, Mass. In 1904 he resigned to take the



W. L. DIERMAN

position of chief engineer and electrician with the Great Northern Portland Cement Co., Marlborough, Mich., where he had charge of the power plant and mill equipment of motors, air compressors, etc. The following year he became connected with the Hudson Portland Cement Co., Hudson, N. Y., as chief engineer and electrician, having charge of the power plant and electric equipment. In February 1906 he was made superintendent of the power department of the Tennessee Copper Co., Copperhill, Tenn., having charge of all power plants of the company, aggregating 10,000 hp. in steam, electric, compressed-air and refrigerating machinery. In 1916, after ten years with the Tennessee Copper Co., he resigned to take the position of chief engineer with the Raritan Copper Works, Perth Amboy, N. J., which position he was holding at the time of his death.

Mr. Fales was a master operating engineer, a member of the Institute of Operating Engineers, and a member also of the National Association of Stationary Engineers. He became an associate-member of the Society in 1914. He died on December 29, 1917.

CHARLES S. FOLLER

Charles S. Foller was born in Buffalo, N. Y., on May 9, 1876. He attended the public schools of that city, and upon being graduated from the high school went to Hobart College, Geneva, N. Y., for a year. He also took special work in Cornell University.

He served an apprenticeship of one year at the machinist's trade with the Lake Shore & Michigan Southern Railway. He was then employed in the drafting room of the Brooks Locomotive Works, Dunkirk, N. Y., afterward accepting a position with the Pittsburgh Locomotive Works as chief draftsman, shortly being advanced to superintendent of frame work in the shops. From 1897 to 1905 he was connected with the designing department of the American Locomotive Co., and at the close of that period was the principal designer of new locomotives of the company. For about a year he was engaged in designing steel cars with the Standard Steel Car Co., Pittsburgh, Pa. For the last twelve years Mr. Foller has been associated with the Union Spring & Manufacturing Co., Pittsburgh, Pa., first as mechanical engineer and then as western sales manager, in charge of the office in St. Louis, Mo. In the summer of 1913 he returned to the headquarters of the company at Pittsburgh as general manager of sales.

Mr. Foller was a member of the Engineers' Society of Western Pennsylvania and the American Society of Testing Materials. He became a member of our Society in 1906. He died in Pittsburgh on December 30, 1917.

EDWARD McKIM HAGAR

Edward M. Hagar was born on June 21, 1873, in Salem, Mass. He was graduated from the Massachusetts Institute of Technology in 1893 with the degree of M.E., and in 1894 received his M.M.E. from Cornell University.

The following year he was employed by the North and West Chicago Street Railroad in their electrical engineering department. In 1895 he became manager of the Chicago office of the Southwark Foundry & Machine Company, and in 1898 founded the firm of E. M. Hagar & Co., western agents for a number of firms handling engines and machinery. In 1899 he was appointed manager of the cement department of the Illinois Steel Co. In 1904 Mr. Hagar became president of the Universal Portland Cement Co., a subsidiary of the U. S. Steel Corporation, and in 1916 president of the Wright-Martin Aircraft Corporation and the Simplex Automobile Co. The following year he was elected president of the American International Steel Corporation.

Mr. Hagar was a member of the American Society of Civil Engineers and of many clubs. He joined our Society in 1895. He died on January 18, 1918.

O. ZELL HOWARD

O. Zell Howard was born in Raleigh, N. C., on December 6, 1876. He was graduated from Lehigh University with the class of 1896, and during the next year was employed in the shops of the Crawford Mfg. Co., Hagerstown, Md.

His drafting-room experience he obtained with the Newport News Shipbuilding and Dry Dock Co., where his work dealt with marine-engine and boiler drafting. His next position was with the Baltimore Smelting and Refining Company on general machine drafting. In 1900 he turned again to marine-engine and boiler drafting with the Maryland Steel Co., Sparrows Point, Md. For about a year he was connected with the Bureau of Construction and Repair, Navy Department, Washington, D. C., on auxiliary machinery, resigning to take the position of mechanical engineer with the American Carbide Lamp Co., Philadelphia, Pa. In 1902 he became an instructor in the department of marine engineering and naval construction in the United States Naval Academy, Annapolis, Md. He assisted the head of the department in preparing textbooks on naval engines and machinery and on mechanical processes. He also assisted in the laying out and the superintending of the erection of experimental turbines and boilers in the Naval Experiment Station at Annapolis, and in making tests on the machinery already erected. For the last three years he has been supervising engineer of the Diamond Match Co.

Mr. Howard was a member of the American Society of Civil Engineers, the American Institute of Electrical Engineers and the Society of Naval Architects and Marine Engineers. He became a member of our Society in 1908. He died on December 20, 1917.

CHARLES D. PARKER

Charles D. Parker was born in 1858 in Worcester, Mass. He was educated in the public schools of that city and later attended Worcester Polytechnic Institute, being graduated with the class of 1879.

His first position was with the Crompton Loom Works at Worcester, where he worked at patternmaking for about six months. For the next year and a half he was in the drafting room, and at that time took charge of the patternmaking and drafting departments.

For the last fifteen years he was mechanical expert of the A.

O. ZELL HOWARD

Burlingame Co., Worcester, Mass., builders of steam engines and sawmill outfits.

Mr. Parker became a member of the Society in 1886. He died on December 7, 1917.

GERALD EDGAR TERWILLIGER

Gerald E. Terwilliger was born on January 9, 1888, in Newark, N. J. He received his early education in the Barringer School, Newark, and entered Stevens Institute of Technology in 1905, from which he was graduated in 1909.

For the next two years he studied law and in 1911 was admitted to the bar of New York State. He specialized in patent law, where his technical training made him very successful. In addition to his legal profession, Mr. Terwilliger was interested in literary work, writing for newspaper and magazine publications. He was the editor of the *Stevens Indicator*, an alumni publication of Stevens Institute.

He became a junior member of the Society in 1910. He died on December 9, 1917.

CANDIDATES FOR MEMBERSHIP

TO BE VOTED ON AFTER APRIL 10

BELOW is the list of candidates who have filed applications since the date of the last issue of THE JOURNAL. These are classified according to the grades for which their ages qualify them, and not with regard to professional qualifications, i.e., the ages of those under the first heading place them under either Member, Associate or Associate-Member, those in the next class under Associate or Associate-Member, those in the third class under Associate-Member or Junior, and those in the fourth under Junior grade only. Applications for change of grading are also posted. Total number of new applications, 134.

The Membership Committee, and in turn the Council, urge the members to scrutinize this list with care and advise the Secretary promptly of any objections to the candidates posted. All correspondence in this regard is strictly confidential. Unless objection is made to any of the candidates by April 10, and providing satisfactory replies have been received from the required number of references, they will be balloted upon by the Council. Those elected will be notified about May 15.

NOTE. The Council desires to impress upon applicants for membership that under the present national conditions the procedure of election of members may be slower than under normal conditions.

NEW APPLICATIONS

FOR CONSIDERATION AS MEMBER, ASSOCIATE OR ASSOCIATE MEMBER

California

LIGHT, ARTHUR H., Chief Engineer, American Beet Sugar Co., Oxnard
TIDALL, PHILLYS A., Chief Inspector, Holt Manufacturing Co., Stockton
WADE, FRANKLIN S., Supt. of Operation, Southern Counties Gas Co. of Cal., Los Angeles

Connecticut

STYER, OLIVER S., Chief Inspector, Pratt & Cady Co., Inc., Hartford

District of Columbia

FRYER, ROSS L., Consulting Engineer, Washington
GILL, JOSEPH R., Mechanical Supt., U. S. Department of Agriculture, Washington
GOODWIN, PERCY F., Captain, Engineers, U. S. R., Washington
HEINE, GREGOR H., Instructor in M. E., Catholic University, Washington
MARTIN, HARRY T., Captain, Ordnance Reserve Corps, U. S. Army, Washington

Georgia

BUSSEY, HENSON E., District Engineer, General Electric Co., Atlanta

Illinois

ARNOLD, DOUGLASS L., Chief Engineer, International Harvester Corp., Chicago
BRIGGS, WALTER B., District Manager, Shepard Electric Crane & Hoist Co., Chicago
DERROM, DONALD L., Works Manager, Munitions Department, Winslow Bros. Co., Chicago
HENSCHEL, OTTOMAR H., Associate Editor, Technical Publishing Co., Chicago
O'CONNOR, JEREMIAH J., Chief Engineer, Feuger High School, Chicago
ROBINSON, WILLIAM A., Secretary and General Manager, Charter Gas Engine Co., Sterling
RULE, PERRIN, Superintendent, Iroquois Iron Co., South Chicago
SMITH, WILLIAM P., General Superintendent, The Frost Manufacturing Co., Galesburg

Indiana

SNIDER, LEWIS A., Consulting Engineer, Snider and Rotz, Indianapolis

Iowa

SAYRE, HERBERT A., Coal Operator, Treasurer, Eagle Coal & Mining Co., Des Moines

Kansas

GREENFIELD, BENJAMIN, Engineer, Steam Power Dept., Empire Gas & Fuel Co., El Dorado

Louisiana

GOULETTE, JEFFERSON D., Construction Engineer and Plant Superintendent, Gulf Refining Co., and Gypsy Oil Co., Shreveport

Massachusetts

MERRILL, MELBON H., Vice-President, Tennessee Eastern Electric Co., Boston
SAWYER, HARRY S., Assistant Works Manager, Wiley & Russell Division, Greenfield Tap & Die Corp., Greenfield
SKENTELBERY, CHARLES, Marine Superintendent, New England Fuel and Transportation Co., Boston
WILDER, CARL D., Assistant to the Superintendent, Reed-Prentice Co., Worcester

Michigan

ERICKSON, JOHN, Electrical and Mechanical Engineer, Engberg's Elec. & Mech. Wks., St. Joseph
LUND, MATTHEW, Vice-President and General Manager, Valley City Machine Works, Grand Rapids

Missouri

KOHN, NATHAN, Owner of The R. K. Engineers, St. Louis
NUTTING, FRANK S., Testing Engineer, Busch-Sulzer Bros. Diesel Engine Co., St. Louis

New Jersey

BALDWIN, CHARLES M., Assistant Inspector of Machinery, U. S. Navy, B. & W. Company, Bayonne
KERR, HOWARD J., Assistant to General Superintendent, Babcock & Wilcox Co., Bayonne
REESE, LAURITS A., Superintendent, Jobbing & Tool Service Division, Edison Phonograph Works, West Orange
VOLZ, PHILIP, Mechanical Engineer, Forstmann & Huffmann Co., Passaic

New York

ANTHONY, MARC O., Consulting Engineer, A. Kimball Co., New York
BATES, JOHN R., Vice-President, Wonham Bates & Goode, Inc., New York
BROWNELL, LOUIS M., Industrial Engineer, C. E. Knoeppel & Co., New York
CRAMER, SIDNEY R., Cost Estimator, American Locomotive Co., New York
DE VOGE, JOHN D., Foreman of Planning Dept., Watervliet Arsenal, Watervliet
DILTS, FRANK B., President, Dilts Machine Works, Inc., Fulton
HUBER, FRED F., Designing Engineer, C. W. Hunt Co., Inc., West New Brighton
ILTIS, JOHN, Designer and Estimator, Guarantee Construction Co., New York
KENNARD, RALPH B., Chief Draftsman, Niagara, Lockport & Ontario Pr. Co., Lyons
KIP, HENRY E., Engineer, Union Carbide Co., Niagara Falls
NOWLAND, BENONI, Superintendent Brass Department, John Thomson Press Co., Long Island City
PROCHAZKA, GUSTAV Z., Scientific Hull Draftsman, Newburgh Shipyards, Inc., Newburgh
SPENCE, PETER C., Mechanical Engineer, Department of Labor, State of New York, New York
TOURNIER, EDWARD J., Chief draftsman, American Ore Reclamation Co., New York
ULMANN, AUGUST, JR., Construction Engineer, Walter Kidde & Co., Inc., New York
WHITE, ELISHA J., General Superintendent, Standard Shipbuilding Corp., Port Richmond, Staten Island
WHITE, JAMES A., Chief Engineer, Harrison Radiator Corp., Lockport
WILLSEA, LOUIS P., President and Treasurer, The Willsea Works, Rochester

North Carolina

CHRISTIAN, CHARLES W., Manager Heating Department, General Fire Extinguisher Co., Charlotte

Ohio

ARTHUR, HARRY G., Machine Designer, Firestone Tire & Rubber Co., Akron
GATES, ROBERT M., Engineer, Thew Automatic Shovel Co., Lorain
HUNTER, JOHN R., Engineer Production, Goodyear Tire & Rubber Co., Akron
LOGEMAN, WILLIAM F., Superintendent The Standard Elec. Tool Co., Cincinnati
MAY, JOHN T. L., Instructor in Mechanical Engineering, Ohio State University, Columbus
YAEGER, HARRY C., Chief M. E., The Dalton Adding Machine Co., Norwood

Pennsylvania

EBERT, GEORGE W., Assistant Superintendent, Pedrick Tool & Machine Co., Philadelphia
LANDRY, JAMES N., Superintendent of Production, Aerial Bomb Div., Marlin-Rockwell Corp., Philadelphia
LEONARD, DAVID E., Chief Inspector, Remington Arms Co., Eddystone
MAGEE, WILLIAM G., Assistant Superintendent, The Baldwin Locomotive Works, Eddystone
MOSES, FRED C., Designing Engineer, Bethlehem Steel Co., Bethlehem

ROBERTSON, WALTER M., Special Representative, Vice-President and General Manager's Dept., Pressed Steel Car Co., Pittsburgh
YINGLING, JOHN C., in Assistant Charge Engineering Department, Iron City Products Co., Pittsburgh

Texas
CLYNE, CECIL B., Sales Engineer, Mine & Smelter Supply Co., El Paso
INGLESH, H. O., Chief Engineer, Southwestern Portland Cement Co., El Paso

Virginia
FULLER, Raymond C., Marine Draftsman, Newport News Shipbuilding & Dry Dock Co., Newport News
VESTAL, FRANK J., Test Engineer, E. I. Du Pont de Nemours & Co., Hopewell Works, City Point

Canada
WEEKS, WILLIAM C., University Club, Vancouver, B. C.

Holland
VAN DIJK, J. W., Manager, Lindeteves Stokvis, New York, India and Holland, Amsterdam

Philippine Islands
ROESLER, BERNHARD K., General Manager of George Whalen & Co., Manila

South America
ONSALDO, PEDOR, Engineer, Chief Director, Compania Industrial de Electricidad, Buenos Aires, Argentina

FOR CONSIDERATION AS ASSOCIATE OR ASSOCIATE-MEMBER

California
PORTER, JAMES W., Assistant to Superintendent, Cowell Portland Cement Co., Cowell

Connecticut
GRAHAM, GEORGE A., Engineer, Naugatuck Chemical Co., Naugatuck

Illinois
LLEWELLYN, PAUL, Works Manager, Interstate Iron & Steel Co., Chicago

Massachusetts
DANIELS, FRED H., Secretary and General Manager, Sanford Riley Stoker Co., Ltd., Worcester
WHITE, PERCIVAL, Automobile Expert, Ordnance Dept., U. S. Army, East Milton

Nebraska
BOWEN, WILLIAM S., In charge Aerological Station, Signal Corps, U. S. Army, Weather Bureau, Fort Omaha

New York
CALHOUN, LEROY V., Assistant Shop Superintendent, Hull Div., Navy Yard, New York
THOMA, ANDREW M., Engineering Department, New York Edison Co., New York

Ohio
ROWELL, JOHN T., Part Owner, Bock Machine Co., Cincinnati

Oklahoma
HEID, J. BENJAMIN, Assistant Mechanical Superintendent, Gosden & Co., Tulsa

England
WHATMORE, ALBERT, Chief Assistant Engineer, The Olympia Oil & Cake Co., Ltd., Selby

FOR CONSIDERATION AS ASSOCIATE-MEMBER OR JUNIOR

Connecticut
BRENNAN, MICHAEL J., Checker of Tool Design, Colts' Patent Firearms Mfg. Co., Hartford
HENRICKSEN, HARRY E., Mechanical Engineer, American Graphophone Co., Bridgeport
WOODS, HAROLD J., Draftsman, Remington Arms U. M. C. Co., Bridgeport

Illinois
CAMERON, WILLIAM E., Maintenance Engineer, Sherwin-Williams Co., Plant No. 2, Kensington
MORGAN, EVERETTE K., General Superintendent, Rockford Drilling Machine Co., Rockford

Massachusetts
SIBLEY, EDWARD W., Mechanical Engineer, Aberthaw Construction Co., Boston

Michigan
SPREEN, CHARLES C., Assistant to Assistant General Manager, Dort Motor Car Co., Flint

New Jersey
CRARY, JAMES H., Inspector of Machinery, Bureau of Steam Engineering, U. S. Navy, and Babcock & Wilcox Co., Bayonne
PERRY, JESSE V., Assistant Superintendent, Spencer Kellogg & Sons, Inc., Shadyside

New York
BRICE, NORMAN E., Mechanical Engineer, The Permutit Co., New York
GARLAND, PHILIP, Mechanical Engineer, Technical Department, The Permutit Co., New York
JONES, WALTER H., Engineering Draftsman, New York Central Railroad Co., New York
MITCHILL, GEORGE L., Chief Inspector, Electric Bond & Share Co., New York

Oklahoma
COLLINS, SAMUEL W., Oil-Drilling Contractor in Oil Fields of Okla., Tulsa
MULLERGREN, ARTHUR L., Secretary and Treasurer, Electrical and Mechanical Engineer, Benham Engineering Co., Oklahoma City

Pennsylvania
TAYMAN, GEORGE S., Mechanical Engineer and Draftsman, Crucible Steel Co., Pittsburgh

FOR CONSIDERATION AS JUNIOR

Connecticut
PAUGH, CHARLES T., Assistant Chief Draftsman, Small Tools Department, Remington Arms & Ammunition Co., Bridgeport

District of Columbia
BOYLES, RALPH R., Draftsman, Ordnance Department, U. S. Naval Gun Factory
FLAD, ALBERT E., Mechanical Draftsman, Engineering Bureau, Ordnance Department
FORD, ARTHUR C., Mechanical Draftsman, U. S. Ordnance, Engineering Bureau
PARKHURST, DOUGLAS L., Mechanical Draftsman, Ordnance Department, War Department

Illinois
MAITRA, KRISHNA M., Special Apprentice, Chicago & North Western Railway, Chicago

Maryland
ADDISON, WALTER W., Chief Draftsman and Assistant to Chief Engineer, Baltimore Tube Co., Inc., Baltimore
MOORE, JOHN H., Production Department, Bartlett Hayward & Co., Baltimore

Massachusetts
KENDALL, GEORGE H., Head of Standards Division, Engineering Department, Norton Co., Worcester
LEVI, ELIJAH, Ship Draftsman, Boston Navy Yard, Hull Division, Boston
WINDLE, ARTHUR E., Cadet in Ground Officers' Training School, Aviation Section, Signal Corps at Massachusetts Institute of Technology, Boston

Michigan
SMITH, JOHN M., Draftsman, The Prescott Co., Menominee

Minnesota
GUNNARSON, CARL A., Assistant Superintendent, Department of Buildings and Grounds, University of Minnesota, Minneapolis
PALMER, LLOYD J., Chief Clerk, Chief Engineer's Office, Northern States Power Co., St. Paul

Missouri
LUBKE, ARTHUR F., Consulting Engineer, St. Louis

New Jersey
GAISSERT, HERMAN O., Mechanical Engineer, Keuffel & Esser Co., Hoboken

New York
BEROLZHEIMER, HENRY, Student in Chemical Engineering, Columbia University, New York
HILL, ERNEST K., Machinist, Thomas Morse Aircraft Corp., Ithaca
PETERSEN, CARL E., Assistant to General Superintendent, Morse Dry Dock & Repair Co., Brooklyn
POLDERMANS, DANIEL, JR., Assistant Secretary and Treasurer, Wonham, Bates & Goode, Inc., New York

Ohio
REHN, OTTO F., Special Apprentice, Buckeye Steel Castings Co., Columbus
HAMILTON, HARRY E., Efficiency Foreman Coke Plant, The Youngstown Sheet & Tube Co., Youngstown

Oklahoma
HIGLEY, Frank R., 1st Lieutenant, Ordnance Department, Infantry School of Arms, Fort Sill

Pennsylvania
LEBAIR, MOREAU S., Assistant to Purchasing Agent, Central Construction & Supply Co., Philadelphia
MURDOCK, ALEXANDER, JR., Engineer, D. L. Taylor Co., Inc., League Island Navy Yard, Philadelphia
TIETZEL, ALBERT M., Designer Coke-Plant Work, Cambria Steel Co., Johnstown
WOLFF, JOHN F., Engineer, The Schwarz Wheel Co., Frankford, Philadelphia

Rhode Island
SMITH, NORMAN H., Draftsman, Potter & Johnston Machine Co., Pawtucket

Virginia
DE KLYN, JOHN, Technical Assistant, National Advisory Committee for Aeronautics, Hampton

Canada
STILES, EDWIN M., Chief Draftsman, Consolidated Mining & Smelting Co., Trail, B. C.

SUTHERLAND, WILLIAM F., Draftsman, Toronto Hydro-Electric System, Toronto

WRIGHT, WILLIAM G., Assistant to Consulting Naval Engineer, Department Naval Service, Ottawa

WOONTON, WILLIAM G., 4th Year Student at Faculty of Applied Science, University of Toronto, Toronto

APPLICATION FOR CHANGE OF GRADING

PROMOTION FROM ASSOCIATE

New Jersey

MOLYNEUX, GEORGE E., Consulting, Development of Inventions, Special Machinery, Bayonne

PROMOTION FROM ASSOCIATE MEMBER

Connecticut

SCHAFER, ROBERT H., Mechanical Superintendent, Bridgeport Brass Co., Bridgeport

SEWARD, HERBERT L., Assistant Professor of Mechanical Engineering, Sheffield Scientific School, Yale University, New Haven

Indiana

WEBSTER, LAWRENCE B., Captain, Ordnance Department, U. S. Reserves, U. S. Inspector of Ordnance, Bartlett Hayward Co., Baltimore

New Jersey

MARLOW, FRANK W., Master Mechanic, Armour & Co., Jersey City

Hawaii

HIND, ROBERT R., Consulting Sugar House Engineer, H. Hackfeld & Co., Ltd., Honolulu

PROMOTION FROM JUNIOR

Delaware

ANDERSON, HENRY, JR., Assistant Engineer, E. I. du Pont de Nemours & Co., Wilmington

District of Columbia

LORD, HAROLD S., 1st Lieutenant Engineer R. C., Purchasing Officer for Engineer Supplies.

Massachusetts

WYMAN, DWIGHT M., Mechanical Engineer, Aberthaw Construction Co., Boston

New York

MAHONEY, JOHN F., Foreman Draftsman, Motive Power Dept., Interboro Rapid Transit Co., New York

WHITING, RICHARD A., Engineering Department, New York Edison Co., New York

Pennsylvania

HALDEMAN, PAUL C., Master Mechanic, Lukens Steel Co., Coatesville

SUMMARY

New Applications	134
Applications for change of grading	
Promotion from Associate	1
Promotion from Associate Member	8
Promotion from Junior	6
Total	149

EMPLOYMENT BULLETIN

THE SECRETARY considers it a special obligation and pleasant duty to make the office of the Society the medium for assisting members to secure positions, by putting them in touch with special opportunities for which their training and experience qualify them, and for helping anyone desiring engineering services. The Society acts only as a clearing house in these matters.

IN forwarding applications, stamps should be enclosed for transmittal to advertisers; applications of non-members should be accompanied by a letter of reference or introduction from a member, such reference letter to be filed with the Society. Copy for The Journal should be in by the twelfth of the month.

GOVERNMENT REQUESTS

MEN WANTED AT ONCE for Government work in Division of Trade Tests as a Committee on Classification of Personnel in the Army—to engage in preparation of data and questions and also outline possible performance tests to be used in carrying out the work in the possible trade ability of men in the camps and cantonments, or some of the work in the new draft. Must be men, if possible, broadly familiar with wide variety of industries and competent to formulate or assist in formulating questions to be used in these matters, correspondence with or visits to individuals or camps nearby, from whom they can obtain original data, or confirmation and testing of data which has been prepared, and otherwise in assisting in the preparation of this material. Subsequently to probably be located in the various camps and cantonments to coöperate with the Army Personnel Officers in the application of data which have been prepared and obtained. 2584.

DRAFTSMEN for Bureau of Ordnance, Navy Department. Graduates in mechanical engineering from a technical school or college of recognized standing and who have had some drafting experience, or men who are competent designers of heavy machinery, engines or shop tools and have had a number of years' drafting-room experience. Pay ranges from $4 to $6.88 a day, depending upon the qualifications of the draftsmen. 2585.

MEN for Inspection Division Ordnance Department, with both technical training and shop experience and who are beyond the draft age; those accepted will be commissioned. Also men within draft age who have the required qualifications and are not in the first class will be considered for commissions. 2586.

ONE HUNDRED CANDIDATES for commissions in Ordnance Officers' Reserve Corps required for Trench Warfare Section of Ordnance Department. Men over draft age, physically sound, of good character, with business experience, university training and technical skill particularly needed. Application form will be forwarded by the Society. 2588.

POSITIONS AVAILABLE

SALESMAN, preferably experienced on conveying machinery. Splendid opening with good future for right man. Please give full details of experience, age, salary expected, etc. Location Missouri. Record and applications confidential. 1186-C.

THE WESTERN ELECTRIC CO. has opportunities for physicists, engineers, designers and draftsmen for work of research, development and design related to problems of telephonic, telegraphic and radio-communication, which are matters of public importance. Both temporary and permanent positions are open. Apply by letter, not in person to F. B. Jewett, Chief Engineer, 463 West St., New York City. 2178-C.

MECHANICAL ENGINEER, technical graduate, with several years' experience along general and mechanical lines. One conversant with industrial machine design preferred. Permanent position with large corporation. State age, college, previous experience and salary desired. Location Cleveland. 2023-C.

MECHANICAL DRAFTSMAN. Young college graduate preferred. General industrial mechanical-engineering work. Permanent position with large corporation. State age, college, experience if any, and salary desired. Location Cleveland. 2024-C.

SALES MANAGER. Engineer experienced in estimating and selling to hold responsible position in long-established engineering and contracting business of an incorporated company. Possible opportunity to become financially interested. Give age and experience in reply. 017-C.

METALLURGIST of good training and reasonable experience for work along lines of heat treatment, experimentation, machine grinding, tube and steel production and gas producers. Location Ohio. 023-C.

DRAFTSMAN, experienced in flour-mill, grain-elevator, power-transmission, elevating and conveying machinery. Location Kansas. 024-C.

DRAFTSMAN-DESIGNER on electrical machinery, etc. Salary $1500 to $1800. Location Bayonne, N. J. 026-C.

ENGINEER AND DRAFTSMAN on designing of marine machinery in a large and long-established corporation. Location near New York. 028-C.

GENERAL SUPERINTENDENT for plant near New York with over 1200 employees. Applicant must have a technical training, a highly developed technique in widely different fields, a keen sense of justice, obvious ability to be a successful executive in a democratic organization, and a thorough appreciation of the importance of making deductions from facts alone. The man chosen for the position will be given opportunity to learn technique and establish himself in the confidence and esteem of the personnel. He will probably not be given full responsibility within a year. Department is one of very large organization and affords opportunity for advancement. 032-C.

MECHANICAL ENGINEER AND MASTER MECHANIC. American preferred, 30 to 50 years of age, for factory employing about 500 people. Well-equipped machine shop for repairs and manufacture of new machinery. Really capable man wanted who has sufficient training and experience to qualify him for his work. Must be a technical graduate, with thorough practical experience; able to handle men; sober, reliable and ambitious. Suitable salary and good future assured to right man. Reply by letter, stating experience and qualifications. Location, N. J. 033-C.

YOUNG MECHANICAL ENGINEER with three or four years' practical experience out of college, for chemical testing of boilers, fans, pumps, etc. Salary depends on man. Apply by letter. Location New York, with occasional trips in the East. 039-C.

DRAFTSMAN for New York office. Man over 30 years of age who is capable of developing suggested ideas in machine tools. Willing to pay $40 per week or more to man of more than average ability. 040-C.

DRAFTSMEN AND DESIGNERS for routine copper and brass mill work. Several men who are qualified to accept such a position. Long experience in a copper or brass mill not absolutely essential, but a good mechanical knowledge is. Location Elizabeth, N. J. 042-C.

YOUNG ENGINEER capable of handling boiler tests to determine the most economical operation under various grades of coal and under different station loadings. Should be familiar with boilers, stokers, methods of testing and the working up of the tests. Location Poughkeepsie, N. Y. 044-C.

ELECTRICAL OR MECHANICAL ENGINEERING GRADUATE in works-engineering division. Prefer man with experience along lines of industrial power-house and electrical engineering. Location Connecticut. 045-C.

APPRAISAL ENGINEERS who have the experience and are competent to make appraisal of equipment and machinery for by-product coke-oven plants, chemical plants, bituminous coal mines, etc. Prefer to engage competent parties in Milwaukee or Chicago. 047-C.

YOUNG EFFICIENCY ENGINEER with practical experience in time study, rate setting, piece, premium and bonus systems, as assistant to head of department. Must be able to supervise. Excellent opportunity. Give age, education, previous experience, salary desired, etc. Reply Efficiency Department, P. O. Box 400, Cleveland, Ohio. 052-C.

HIGH-GRADE TECHNICAL SALES ENGINEERS with personality, and experienced in gasoline trucks. Men who are producers, have made big money and who are able to stand prosperity. Experience must cover gasoline truck sales. References must be without question. 054-C.

ASSISTANT TO SUPERINTENDENT of mechanical department, a portion of the time as draftsman. Must be a technical graduate engineer with at least five years' experience in an industrial plant, preferably a glass manufacturing concern. One having some experience in handling men and who has been successful in getting results in general plant construction, upkeep and maintenance, and also construction and maintenance of machinery, power plants and glass-house furnaces. Location New York State. 056-C.

DRAFTSMAN experienced in glass-house or steel-furnace design and construction; must have several years' experience. Location New York State. 057-C.

DRAFTSMAN experienced in general industrial plant, machinery repair and upkeep. Location New York State. 058-C.

DRAFTSMAN with at least six months' experience in mechanical designing for department of experimental engineering. Must have original ideas and initiative. Salary to start $1200. Location Connecticut. 059-C.

DETROIT SALES REPRESENTATIVE. Capable engineer to handle steam-heating specialties in Michigan. Salary, commission and expenses. State experience fully. 060-C.

ENGINEER skilled in the design of small steam turbines to design an efficient steam turbine of less than 10 hp. Temporary position. Location Pennsylvania. 064-C.

CHIEF ENGINEER to run plant of 2400 boiler hp. situated in New Jersey. Must have had practical experience with Corliss engines, condensing and auxiliary apparatus and methods of securing economical boiler operation. Must be able to control help. Mechanical experience necessary, technical experience desirable. 065-C.

BOILER-ROOM EFFICIENCY MAN. Young man who has tact, a pleasing personality and the perseverance to get the desired results. Should have a general knowledge of power plants and their operation and, if possible, actual experience in the operation of a power plant. Salary commensurate with ability to produce results. Location Rhode Island. 066-C.

HIGH-GRADE MECHANICAL ENGINEERS of construction experience for work on powder and explosive plants for U. S. Government. Apply, stating age, nationality, experience, references and salary desired. Location Delaware. 067-C.

SALES ENGINEER, between 25 and 30, for condenser and cooling plants. State experience, salary expected, and give references. Location Pennsylvania. 072-C.

SALESMAN experienced in high-class Diesel or semi-Diesel fuel-oil engines. Unusual opportunity on a salary and commission basis in desirable territory, covering a superior line of engines. State age, education, experience, etc. Location Illinois. 073-C.

SALES ENGINEER, high-class man, experienced in sale of Diesel or semi-Diesel fuel-oil engines; man of strong personality, capable of organizing and superintending agencies. A very attractive opportunity. Give, in confidence, age, education and experience. Location Illinois. 074-C.

ASSISTANT AND FOLLOW-UP MAN on operation of shell shop. Should be systematic and painstaking and have a general knowledge of mechanical drawings to readily identify parts and keep account of work in the shop. Location New Jersey. 075-C.

GENERAL FOREMAN for factory employing 100 men. Must be competent executive and experienced in manufacture of three-jaw independent chucks. Location Chicago, Ill. 076-C.

MECHANICAL ENGINEER with executive ability, experienced as experimental engineer on woodworking machinery. Salary depends on man. Location Middle West. 077-C.

SUPERINTENDENT in machine shop employing about 100 men. Technically trained man who has had actual experience as superintendent of a machine shop. Product is hand elevating trucks for use in factory transportation. Location Massachusetts. 080-C.

TOOL DRAFTSMEN for engineering department of concern. Brooklyn. Pay to start is $35 a week, with promotion; 48 hours a week. 081-C.

DESIGNER experienced on hydraulic presses and pumps. State experience and past connections. Location Illinois. 082-C.

MECHANICAL DRAFTSMAN for permanent position. Working conditions and prospects good. Location Minnesota. 083-C.

TOOL DESIGNER. High-grade man experienced on heavy automatic screw-machine tools. Must be capable of standardizing tools and records. Write, giving full details as to experience, references and salary expected. 085-C.

SUPERINTENDENT for boiler shop combined with heavy tank and plate works, also making light tank work, stacks, breechings, etc. Desire man of executive ability, organizer and one who can handle foremen and men for highest efficiency. State experience and salary expected, also when available. Location Middle West. 086-C.

DRAFTSMAN who is an experienced designer of railway cars, to design draft gear, journal boxes, etc., and make engineering calculations relative to same. Rate of pay in accordance with the ability of the man and general rate prevailing for such services at the present time. Wanted for a permanent position. Location New York State. 087-C.

STAFF OF 100 BIG MEN wanted by large industrial plant in Alabama engaged in important Government work. Superintendents, assistants, foremen and chief operators are needed. Chemical, electrical, electrochemical, gas, liquid air, refrigerating and mechanical engineers, all with operating experience; college men with technical training, and familiar with cement, power, refrigerating, chemical, sugar-refining and electric plants; operators experienced on mining and milling machinery, crushers, conveyors, compressors, furnaces, kilns, ovens. Competent men will be trained in the processes, paid good salaries during instruction, and given an attractive contract as soon as qualified. State age, nationality and experience. 088-C.

MEN AVAILABLE

SUPERVISING FUEL-EFFICIENCY AND WATER-SOFTENING ENGINEER. Member, under 40, with technical education and 18 years' experience in the construction and operation of steam plants, the handling of all classes of men, the testing and chemical treatment of waters, and in the burning and testing of gas, oil and all grades of anthracite and bituminous coals. Knows how to obtain results. Position must carry full authority and pay not less than $4000. C-54.

CHIEF ENGINEER OR MASTER MECHANIC with thorough technical and practical experience covering construction, operation and upkeep of steel plant. Specialty metallurgical work, heating and melting furnaces. C-55.

SAFETY ENGINEER with six years' thorough technical and practical experience in this capacity with large steel works in Pennsylvania. C-56.

ELECTRICAL - ENGINEERING GRADUATE with two years' mechanical experience in design of oil-well tools and machinery, including gas engines, compressors, pumping jacks, etc.; also experienced in design of machinery for manufacturing 6-in. shells. Student of Alexander Hamilton Institute. Prefers Government work, but will consider anything paying over $125 per month. C-57.

EXECUTIVE MANAGER. An executive of ability and aggressiveness, a mechanical, technical graduate, at present employed, desires to connect with a manufacturer whose business may need systematizing and building up as to organization and production. Has had a varied experience in different branches of manufacturing, operating industrial plants along lines of scientific management, and is fully conversant with modern methods of manufacturing and marketing products. Only interested in a permanent position offering good possibilities for improvement. C-58.

MECHANICAL ENGINEER. Member, technical graduate with over 20 years' shop and mill experience wishes to locate with large New England concern in executive capacity. An important opening only considered. Now employed. C-59.

MECHANICAL ENGINEER experienced in the design of power plants, industrial plants, heating, ventilating, etc. Has held executive positions and had charge of men. Desires responsible position. C-60.

AVAILABLE FOR GOVERNMENT SERVICE MARCH 1—INDUSTRIAL AND PRODUCTION ENGINEER with 17 years' manufacturing experience in metal-working trades. At present chief of production at plant employing 2600. Practical man, with exceptional experience, who desires to enter Government service. C-61.

STEAM ENGINEER wants position with large power or industrial company; six years' technical training in electrical and mechanical engineering, five years' experience in steam-power work; familiar with all types of steam and electrical equipment. Associate-member, A. S. M. E. Can furnish the best references. Will be available March 1. C-62.

MECHANICAL-ELECTRICAL ENGINEER. Columbia graduate, at present employed as manager of a very large concern, desires position as sales manager or superintendent. Experienced in internal-combustion engines and foundry and machine-shop practice, gas producers, power installations and marine power plants. Unusual business and technical training. Fully conversant with French, Italian and Spanish. Minimum salary to start $4000. C-63.

MECHANICAL-ELECTRICAL ENGINEER. Cornell graduate, age 32, married, desires executive position in the production or manufacturing department of a progressive concern where initiative and tact, coupled with past training and experience, will be of maximum value toward further advancement; experienced in machine-tool operation, design of labor-saving devices and special and automatic metal-working machinery; systematizing, production engineering, etc.; first-class references as to character and ability. Available on two weeks' notice. C-64.

INSTRUCTOR OR ASSISTANT PROFESSOR OF MECHANICAL ENGINEERING. Technical graduate with shop, drafting-room and teaching experience; can also handle military instruction. Services available at end of present semester. Location preferred Eastern or Middle Western States. C-65.

MANUFACTURING ENGINEER, 33, married, desires permanent responsible position. Thorough mechanical and efficient production experience with fine machines and sheet-metal goods. Present duties deal with labor-saving devices, estimates, investigations, rates and bonus layouts, instructions, etc. Salary $2500. C-66.

MECHANICAL OR WORKS ENGINEER. Technical graduate, age 30, married. Good organizer and executive, experienced in design, construction and maintenance of paper mills and metal-manufacturing plants and in management of shop, yard, office and drafting-room forces. Location Eastern States preferred. C-67.

POWER-PLANT ENGINEER with 26 years' experience. Can build and operate. C-68.

MECHANICAL ENGINEER AND SUPERINTENDENT. American, with 14 years' practical and theoretical experience. Specialist in steam, air, gas, oil and water engineering specialties; machine-tools, fixtures and shop equipment; shop maintenance, efficiency, engineering testing and production engineering. Executive who can go into shop and do things. Successfully held positions involving above. At present employed. Salary $3000. C-69.

MECHANICAL ENGINEER desires executive position in organization where small or medium-sized work is manufactured. Fourteen years' practical experience as tool and die maker, tool and automatic-machine designer and chief designer. At present assistant works manager in one of the best tool-manufacturing concerns in the country. Present salary $2500 plus bonus. C-70.

MECHANICAL ENGINEER OR ENGINEER OF CONSTRUCTION. Junior member, age 27, University of Pennsylvania graduate, married, class 4-A Federal draft. Engaged in gas, by-product coke, benzol recovery and power plants, erection and operation. Desires permanent position with growing concern where merit is appreciated. At present employed. Best of references. Salary to start $175. C-71.

CHIEF DRAFTSMAN OR PRODUCTION ENGINEER. Eleven years' experience in general engineering, charge of design of internal-combustion engines, railway cars and equipment, furnaces, plant layouts, installation of machinery, automatic machinery, jigs and tools, production, efficiency and routing. At present in charge of technical and mechanical problems in consulting capacity. Position must be permanent. Location New York City or vicinity. Salary $2200 to $2500. C-72.

INSTRUCTOR OR ASSISTANT PROFESSOR OF INDUSTRIAL ENGINEERING. Junior member, age 26, married, M. E. from prominent Eastern university, is looking for a change where he will have charge of the shopwork and teach subjects in industrial engineering. Has had general mechanical experience and since graduation studied and worked under a pioneer in the teaching of scientific management. For three years has taught shopwork under applied methods of shop management, had charge of the machine shop and taught time study, cost accounting, etc. Would assume new duties about September 1, but is desirous of starting correspondence now with those interested. Prefers to locate in the East. Minimum salary $1600. C-73.

ASSISTANT TO EXECUTIVE OR EXPERIMENTAL ENGINEER. Stevens M. E. graduate, 28, married, finishing present engagement some time in March. Three years' successful experience in executive and experimental work in natural gas, two years in power-plant operation. Possesses energy, initiative, self-confidence and unusual mathematical ability. Desirous of securing a position with large industrial or engineering concern. Position must be permanent and offer a future. Initial salary not a primary consideration. C-74.

DESIGNING ENGINEER, CHIEF DRAFTSMAN OR MECHANICAL EXECUTIVE, age 36, technically qualified; practical and supervising experience and competent to design, develop and standardize mechanical products, particularly machines involving complex mechanism and covering a range of sizes, or to organize or direct a department for such work. Specialized knowledge of design and production of a leading line of high-grade textile machinery and accessories, also valuable experience on steam and hydraulic appliances. Prefers connection with growing concern whose expansion calls for establishment of mechanical-development department, handling problems of product and equipment. Salary $3500. C-75.

EXECUTIVE OR ASSISTANT SUPERINTENDENT. American, technically educated, age 36. Practical mechanic, familiar with design of special machinery, tool, jigs, fixtures, etc., for manufacturing duplicate parts on interchangeable system. Twelve years in drafting room, part of time as chief draftsman; six years' shop experience, one as foreman. Salary $2500. Location preferred Eastern States. C-76.

MECHANICAL ENGINEER, Associate-member, age 34, with 12 years of broad experience in designing and construction of various automatic and special machinery. Practical man with executive ability and thoroughly versed in modern methods of interchangeable manufacturing. At present connected with a large corporation, but desires permanent position with prospects for future advancement. Salary $3000. C-77.

MECHANICAL AND MARINE ENGINEER, age 40, with 15 years' experience in the design and construction of ships and power equipment, engines, boilers and auxiliaries; also experienced along general engineering lines and electricity. Thoroughly competent to handle men and take charge of the design and construction of merchant ships and machinery. Good reasons for wanting to make change. C-78.

MECHANICAL ENGINEER with 10 years' experience in building and tool valuations and field engineering along the lines of mill and power buildings. Now open for engagement. Location Chicago or vicinity. C-79.

SALES ENGINEER. Member, age 34, experienced in the manufacture and selling of iron and steel, wishes position with high class firm as production or sales engineer. At present employed. C-80.

PLANT ENGINEER. Member, age 39, with 12 years' experience in plant upkeep, designing new buildings and equipment, labor-saving and material-handling devices, repairs to machinery or equipment, power, light, heat and plumbing. At present and for past five years with large metal-working plant. Record or experience and references to those interested. C-81.

TECHNICAL GRADUATE (1904), member A.S.M.E., now employed as mechanical engineer and managing two steam-turbine plants, desires executive position with large manufacturer or public-utility company. Experienced in design, construction and maintenance of high-tension sub-stations, steam plants, piping, buildings, steam and electrical equipments. Best references. Locality Eastern States preferred. C-82.

ENGINEERING SURVEY

A Review of Engineering Progress and Attainment in Mechanical Engineering and Related Fields, Including a Digest of Current Technical Periodicals and Selected Titles of Engineering Articles

Saving Fuel Through Operating Economies in Electric Street Railways

THE Electric Railway War Board has recently made public the report made last December by a committee appointed to investigate the fuel savings possible on the street railways in Washington, D. C.

The report covers partly conditions peculiar to the city of Washington, but also touches upon subjects of general interest to electric street railways.

The report shows that the present system of car stopping at every corner (in some cases because of local regulations, even when there are no passengers to take on or discharge) involves a considerable delay in the operation of the cars and a material increase in the consumption of the coal. The committee recommends, therefore, the use of the skid-stop plan, or stopping at alternate corners, as well as the elimination of stopping at rapid-transit corners and other minor delays in operation.

Another recommendation covers the elimination of the present system of running an unnecessary number of cars to the far end of lines where there is not enough traffic. It is believed that for the Washington railways the elimination of unnecessary mileage would save approximately 3200 tons of coal per year.

Still another recommendation covers the generation of the entire power load for the two lines operating in the city at the most efficient plant of one of these companies. It has been found that because of various existing conditions one plant is able to operate with 1.9 lb. of coal per kw-hr., while the other two plants consume 2.6 lb. and 4.1 lb., respectively. Making suitable allowance for losses in transmission, the saving in coal from shutting down these two latter plants is estimated at 9700 tons per year.

A suggestion which might apply to a good many cities besides Washington, of course with proper modifications to meet local conditions, refers to staggering office hours of Government employees. It seems that there are nearly 50,000 Government-department employees who are dismissed each day at 4.30 p.m. This requires a material increase in the number of cars after 4 p.m., which can in a general way be attributed to the necessity for carrying department employees. Most of these additional cars, it is to be noted, make only two round trips.

If the office hours were staggered so as to begin at 15-min. intervals from 8.30 a.m. to 9.15 a.m. and to close correspondingly from 4.00 p.m. to 4.45 p.m., considerable relief would be obtained in street congestion and a saving effected in coal. It is estimated that on such a basis the rush-hour cars could make three trips instead of two, which would cut down the number of additional cars required for this purpose by a third.

It is interesting to note that while the total consumption of coal on the Washington street railways amounted to about 12,760 tons per month, the recommended savings would reduce this consumption by 25,790 tons per year. (*Electric Railway Journal*, vol. 51, no. 6, February 9, 1918, pp. 267-270)

Reorganization of the Quartermaster General's Office

Reorganization of the staff of the Quartermaster General was completed by Gen. George W. Goethals, Honorary Member Am.Soc.M.E., on January 26, and in addition to a general rearrangement of the administrative boards, it includes the storage and traffic service for the general staff.

In the general scheme of the new organization there are three service bureaus, but the Storage and Traffic Organization, comprising four operative divisions, is largest by an additional bureau called the Distribution Priorities Bureau. The function of this service will be to advise the Director of Storage and Traffic with respect to all matters of priority and distribution and to secure data on which to base the apportionment of the use of storage, transportation and embarkation facilities among the various operating divisions.

The three other bureaus embodied in the new organization are as follows:

The General Administrative Bureau has control of the preparation of data and orders for executive action, verification and approval of estimates and supervision of general administrative procedure in the various offices of the Quartermaster's Corps. It also includes an Information and Statistics Section and a Contract Supervision Section.

The second bureau is the Quartermaster's Supply Control Bureau, which comprises a Requirement Branch, a Distribution Branch (for both domestic and overseas troops), and an Administrative Branch.

The third is the Professional and Planning Staff, which supervises and orders all matters relating to office service, administrative methods, operating methods, industrial research, industrial relations and kindred matters for several operating bureaus.

In the reorganization of the immediate staff of the Quartermaster General several operating divisions have been created, each having its own Procurement Branch and Production Branch.

The above information is taken from the *Engineering News-Record* of Feb. 7, 1918, vol. 80, no. 6, pp. 248-250. The article has two charts, of which the second gives the personnel of the chief division of the Quartermaster's Corps.

U. S. Plans to Use Surplus Northwest Water Power in War

The Government is preparing to use the surplus water power of the Northwest for war industries.

A survey will be the first step. It was ordered last December by the power committee of the Council of National Defense. C. O. Frisbie, of Chicago, president of the Wood Products Co. at Cornell, Wis., and head of the Chippewa Valley Operative Association, was selected for the task, and will begin at once.

The power committee has asked for the following information:

How much power is developed from Government and private dams in Minnesota and Wisconsin?

How much additional power can be obtained by improvement of the present facilities?

How much surplus over the present needs of industries and municipalities can be produced?

How much can the present users of power curtail their consumption?

How much of their supply will present users be willing to divert for Government purposes?

It is believed that the survey will disclose thousands of horsepower readily convertible to industrial users. Chippewa Falls and International Falls are the two points from which most is expected, but a close study will be made of the entire field.

The hope is to obtain coöperation of local industries and municipalities in getting much needed power for new war plants. Failing in this, the Government will not hesitate to commandeer the output, as was done at Niagara Falls last week by President Wilson.

The coal shortage makes it imperative the Government turn more to the use of water power. New factories, especially chemical plants, must be built, and the only hope of operating these at capacity and meeting the other fuel needs of the country is to utilize natural power.

Until Mr. Frisbie has completed his work and made his recommendations to the power committee there will probably be no decision in the disposal of surplus power from the high dam at the Twin Cities. (Minneapolis *Morning Tribune*, December 31, 1917, p. 1)

New Gun Plant of the Tacony Ordnance Corporation

The Tacony Ordnance Corporation is rapidly completing extensive and modern facilities for the production of large-caliber, rough-machined gun forgings. The plant, which will cover approximately 22 acres at Tacony, Philadelphia, will be completed about March 1, 1918. Present plans call for the following buildings: open-hearth and stock yard, forge, heat-treatment, machine-shop, chemical, physical and microscopic laboratory, storehouse, dispensary and administration building.

The open-hearth, which will have a capacity of from 700 to 800 tons of ordnance ingots per week, will operate two 40-ton acid, oil-burning furnaces, with 3½-ton charging machine, cranes, oil-storage tanks, etc. A 2000-ton and a 1000-ton steam-hydraulic forging press, with heating furnaces, etc., will furnish ample forging capacity. In the heat-treatment department there will be three vertical quenching and three car-bottom furnaces with necessary pyrometric control and dipping cranes. The machine shop will house about 50 machine tools, including a number of 48-in. and 36-in. turning and boring lathes, shapers, planers, etc. A small but complete toolroom will be maintained.

The new plant will be devoted exclusively to the production of rough machine forgings for howitzers and guns for the United States Army. About 500 to 600 employees will be required to operate the plant at capacity. J. B. Warren, secretary and manager of the Tacony Steel Co., is president of the Tacony Ordnance Corporation, and George Satterthwaite, formerly general superintendent of the Midvale Steel Co., is vice-president and general manager. (*The Iron Age*, vol. 101, no. 2, January 10, 1918, p. 175)

Softened and Asphalted Paper for Wrapping

A practical substitute for burlap to be used for baling and wrapping purposes was recently put on the market by the Cleveland-Akron Bag Company, Cleveland. Burlap substitutes are now of interest, as available supplies of burlap have had to be diverted for use to such purposes only as cannot be filled by other materials.

Machinery and machinery parts, electric motors and dynamos are wrapped for shipping in burlap; for coils of wire and auto tires narrow strips of burlap are used. Burlap is put to hundreds of such purposes which can, and to save burlap for more essential uses should, be performed by other practical substitutes.

The new substitute, "Saxolin," is made of two pieces of heavy paper combined with an asphalt material, making a waterproof combination. In the manufacturing of this product it is softened and made pliable so that the folding qualities of the paper are retained.

In tensile strength it is said to test equal to burlap used for a like purpose. There are four different weights corresponding to different grades and weights of burlap.

"Saxolin" cannot fill all the purposes of burlap, but in the range that it can supply, it will aid to place the available supply of burlap in the channels most needed. (*Journal of Commerce*, January 3, 1918, p. 17)

Pulverized Coal for Central Railroad of Brazil

The Central Railroad of Brazil recently inaugurated a series of experiments with its new coal-pulverizing plant at Barra do Pirahy, which caused considerable interest and favorable comment in engineering circles, according to the *Commerce Reports*. The plant was furnished by an American firm and installed by one of its engineers. The pulverizer is described as being similar in construction to a cement plant. The coal, freed of its moisture, goes into a hopper and is pulverized so that 80 per cent of it can pass through a 200-mesh screen. It is then passed to the locomotive by means of a conveyor screw and blast, thus bringing the ignitable powder to the mouth of the locomotive furnace, at which point combustion takes place. The first set of experiments were with American coal and were an unqualified success. The experiments were then continued with a mixture and finally with Brazilian coal from the Jacuhy district, until now somewhat problematically useful—"problematically useful" because it is a coal that does not burn economically in the usual lump form. It was, however, believed that, once pulverized, this coal would give good results and would prove to be adaptable to the needs of the railroads. The experiment, as reported, was an unqualified success and was hailed as an auspicious event that represents the solution of one of the most vital national problems in Brazil. (*Power*, vol. 46, no. 24, December 11, 1917, p. 793)

French Method of Tinning Cast-Iron Vessels

A method for tinning cast-iron pots and other utensils for domestic use is offered from a French source, *La Chronique Industrielle*. For household utensils only pure tin should be employed and not tin and lead, as the latter forms poisonous salts with the acids of food products. To insure adhesion of the tin the iron should be treated to remove the carbon, or otherwise it should be polished by mechanical means To remove the carbon, the iron is coated with a layer or oxide of iron or manganese, or else the iron is enclosed in a box with

the oxide and maintained at a high temperature to burn out the carbon. After four to six hours the iron is sufficiently decarbonized to permit the adhesion of the tin. After this procedure the iron is cleaned with dilute sulphuric acid to which is added a small amount of blue vitriol. The iron is then immersed in molten tin, or, if the interior of the vessel is to be coated, molten tin with a little sal ammoniac is vigorously rubbed over the surface. It is preferable to heat the iron before applying the tin. This must be done with care, otherwise the surface will be oxidized and impair the adhesion of the tin. (*Mechanical World*, vol. 62, no. 1616, December 21, 1917, p. 337.)

Society of Automotive Engineers

At the monthly meeting of the Minneapolis Section held in connection with the Twin City Automobile Show the important problem of burning kerosene in tractor engines was discussed. Professor Mowry of the State Agricultural College took the stand that the increased use of kerosene and heavier fuels is more dependent on engine designers than on carburetor or manifold makers. He quoted figures from tests made at his university on kerosene fuel with hot-spot manifolds. The tests were made with a four-cylinder L-head engine with a removable head and the duration of the test was 1 hr. Water temperatures ranged from 190 to 212 deg.

The tests were made with several types of manifolds and vaporizers and the dilution of the crankcase oil due to the admixture of kerosene in the crankcase varied from 0.1 to 0.7 lb. In some manifold tests it was even impossible to run the engine the full hour, because after about half an hour it stopped through preignition.

W. G. Clark, engineer of the Wilcox, Bennett Carburetor Company, who has just returned from a three months' investigation trip among tractor farmers from Texas to Montana, declared that the situation so far as burning kerosene in tractors is concerned is very serious, due to tractor makers selling tractors that are supposed to burn kerosene satisfactorily, but which fail to do it in the service of the farmers. He claimed that the hot-spot manifold is not a solution of the kerosene problem, because it increases the temperature of the mixture too much and cuts down the volumetric efficiency of the engine so that from a quarter to three-tenths of the engine power is lost.

E. R. Greer, engineer of the Emerson-Brantingham Company, expressed the opinion that the hot-spot manifold to accomplish its object must have some form of heat control. Consideration must be given to the speed of travel of the mixture in the manifold as well as the temperature of the manifold. When there are high gas speeds with open throttle, less heat is needed, but when the throttle is closed, heat must be added to prevent loading up. (Based on the report published in *Automotive Industries*, vol. 38, no. 7, February 14, 1918, p. 380.)

Hydroelectric Development

At the meeting of a special committee of the United States Chamber of Commerce on January 14, 1918, a statement was submitted on behalf of the Engineering Council by Calvert Townley, touching upon the subject of hydroelectric development generally and as a means of replacing steam power plants.

There are two fundamental causes which have militated against the substitution of hydroelectric for steam-electric power. One is economic and permanent, the other is statutory and therefore subject to modification.

The economic reason is the high cost of development due to natural conditions. Hydroelectric plants usually carry much heavier fixed charges than steam-electric plants, partly because in a water development a large share of the initial cost is consumed by expenditures for riparian rights, the dam and other hydraulic installations, transmission, right of way, towers, etc. A further share of the greater first cost of hydroelectric plants is due to the fact that, unlike the steam plant, the hydroelectric plant at the start must largely be built with a view to the future and not the actual market, and therefore for years has to carry excessive overhead. As a result, the projectors of the hydroelectric enterprise must often rely for success on a subsequent increase in their market, and the possibility of an incorrect forecast of the extent of such increase and of the time when it may come, imposes a serious business hazard against water and in favor of steam.

Another element in favor of steam is, that with the growing advancement of the art, both the first cost of machinery per unit of power and the cost of operation in the case of steam prime movers tend to decrease, and there is nothing to indicate that the limit of improvement in the design of steam prime movers has been reached or is even in sight. Further, where fuel oil is available, the Diesel or internal-combustion engine is also coming forward as a competitor of water power.

In fact, many sites which fifteen years ago might have been developed to sell energy in successful competition with steam at its then cost, could not now be so developed. On a concrete example, the report shows that the cost of fuel per unit of installed capacity in a steam-electric plant of average good design may be taken at $11.50 per year. Under the usual conditions this would mean that a hydroelectric plant would be superior to or at least equal to this steam plant provided the hydroelectric investment per kilowatt capacity exceeded that of the steam plant by not more than $100. As a matter of fact, many hydroelectric developments exceed this limit considerably, in which case they can be commercially successful only if either they are located in sections where coal is more than normally high, or are operating under more than usually favorable conditions, for example, with a plant factor in excess of the usual 35 per cent.

The conclusion which the report emphasizes is that while under certain conditions water power may commercially compete with steam, the view that it can under all conditions produce power at the lower cost than steam is quite a mistaken one.

The report proceeds to discuss certain legal obstacles in the way of water-power development in the United States, and shows, for example, that the discretionary right given to the Secretary of the Interior to revoke permits for the use of public land necessary for water-power developments, operates against the flow of private capital into such projects.

While the Engineering Council does not consider itself as expert in legal matters, the report points out that after a hydroelectric enterprise has been successfully established it is to everybody's interest that it should continue without interruption and all legal obstacles in the way of its operation should be as far as possible eliminated.

The report further expresses the belief that the benefits afforded the communities served by cheap power and the nation by the conservation of coal are far more valuable than the question of restricting returns to capital. The present emergency has shown how important the substitution of water power for steam power might be in releasing to other uses

the extensive transportation facilities now engaged in carrying coal as well as the corresponding volume of labor now occupied in mining this coal, and in converting it into motive power.

Engineers Control War Industries

Germany had prepared for a six months' war. Her supplies, her armies, her transportation system were all tuned for this period. For the general staff had figured the campaign with such precision that any greater extension of preparation would be a waste of national effort. Only one man in the empire felt that the chance of plans miscarrying was of sufficient importance to provide against. This man, an engineer high in the counsel of the Allgemeine Elektricitäts Gesellschaft, felt that to enter into a project as subject to failure as a military campaign, without a plan whereby every resource of the nation might be concentrated on the effort, was suicidal. But he had to wait for the stalemate of December to obtain the opportunity of putting the whole of the industrial resources of the country on a planning and progress chart basis.

This sidelight on the military situation in Europe at the beginning of 1915 is neither invention nor rumor. It is fact, well vouched for by men of undoubted reliability. Therefore, it should be welcome news to the engineers of America to know that a start in the proper direction has already been made in this country. The Office of the Chief of Ordnance has had for some time a planning division in certain of its own shops, and is now extending this most important work to all the factories making supplies for the office. The Progress Section of the Control Bureau, functioning as a division of the Ordnance office, keeps its mind on the progress of all war orders within its jurisdiction. Under Major Sanford E. Thompson, Mem. Am. Soc.M.E., a corps of men keep in touch with the promises and performances of manufacturers, determine wherein lies the cause of delays and what steps must be taken to keep production up to the schedule of requirements which have been determined as necessary to our full and successful participation in the war.—*Engineering News-Record*, February 14, 1918.

This Month's Abstracts

Special attention is called to a remarkable investigation on measurement of torsional stresses abstracted in the section Mechanics.

As yet we have no means of measuring torsional stresses directly. In members of very simple cross-section, for example, circular, we can determine the torsion mathematically with considerable precision, but this is not feasible in the case of members of complicated cross-section, such as, for example, aeroplane struts. Nevertheless, this is a case where measurement of torsion is especially important, as aeroplane members must be both of ample strength to meet possible peak loads, and also of minimum weight—two conditions which require considerable knowledge of the properties of materials used and stresses to which these materials are subjected.

Griffith and Taylor have solved this problem by the so-called soap-film method described in the abstract. It is of interest to note in this connection that the properties of soap films and soap bubbles have recently been investigated in several respects, and there is gradually being built up what one might perhaps call "soap-bubble engineering," in the better sense of the term.

The Pittsburgh Testing Laboratory, Pittsburgh, Pa., is now engaged on a five-year test of coarse aggregates in concrete. The results obtained in the first six months are reported in the section Engineering Materials.

In the same section will be found a discussion of the different rates of loading as affecting the compressive strength of concrete.

In the section Hydraulic Engineering is described the equipment of the White River plant, containing two very large Francis turbines operating under a net head of 440 ft. The most interesting feature of this installation is its system of regulation and protection.

The section Internal-Combustion Engineering contains descriptions of several interesting devices.

The Chapman Engineering Company has developed a gas producer with a floating agitator, so arranged as to continuously stir up the entire surface of the fire bed in the producer.

From an English publication is reproduced a discussion of the time required for exhaust pressure in a two-stroke-cycle engine to fall from its initial value to the atmospheric level. A formula is given which makes it possible to determine the position of the piston for any crank angle.

In an abstract published in THE JOURNAL in January 1914 were described the general features of the Kromhout oil engine. In the present issue a unit is described developing as high as 350 hp. and having some interesting features of governing.

G. E. Stoltz, in an abstract in the section Mechanics, discusses the design of flywheels for rolling mills and shows how a comparatively small flywheel properly located may increase the monthly output of a mill by approximately 10 per cent.

The automatic control and measurement of high temperatures is exhaustively discussed by Richard P. Brown in a paper before the Steel Treating Research Society. Among other things are described instruments for the various temperature measurements and automatic temperature control.

In the section Munitions, particular attention is called to the bibliography on gages and gage making for munition plants, prepared by the Library of the United Engineering Societies. No attempt has been made at making an exhaustive bibliography, the aim being mainly to give a list of papers and articles of particular value to American manufacturers.

A new system of locomotive feedwater heating is described in the section Railroad Engineering. One interesting feature of the heater consists of the agitators contained in each of the tubes, so arranged as to bring each particle of water in contact with the hot tubes and to absorb all the heat possible from the exhaust steam on the outside of the tubes. It appears that the higher the velocity of the cold water passing through the tubes, the more violent the agitation and the greater the amount of heat absorbed by the water.

From British publications an abstract is made of a report submitted to the North-East Coast Institution of Engineers and Shipbuilders on various methods of producing high vacuum.

Soon after the beginning of the war various conditions combined in preventing copies of German technical periodicals from reaching this country. In particular, copies of the *Journal of the German Society of Engineers* ceased to come about the middle of 1915. Arrangements are now being made to secure the back issues, and there is good reason to believe that the Society will have them ere long. In that case some arrangement will be made to make the valuable information contained therein available to the membership of the Society.

REVIEW OF ENGINEERING PERIODICALS

SUBJECTS OF THIS MONTH'S ABSTRACTS

DOPPLER EFFECT
SLAG-CONCRETE TESTS
FIRE TESTS OF BUILDING COLUMNS
RATE OF LOADING AND COMPRESSIVE STRENGTH OF CONCRETE
GERMAN-MADE BOILER TUBES
GAS-FIRING BOILERS
LARGE HIGH-HEAD FRANCIS TURBINE
WATER TURBINE REGULATORS
GAS PRODUCER WITH FLOATING AGITATOR
CENSUS OF INTERNAL-COMBUSTION ENGINES
EXHAUST-GAS FLOW IN 2-STROKE-CYCLE ENGINES
KROMHOUT MARINE ENGINE
FLYWHEELS IN ROLLING MILLS
TORSIONAL STRESSES, MEASUREMENT OF
SOAP-FILM METHOD OF MEASURING TORSION
HIGH TEMPERATURES, CONTROL AND MEASUREMENT
NOSING MACHINE FOR THIN-WALLED SHELLS
MUNITION GAGES AND GAGE MAKING, BIBLIOGRAPHY
JOLIET POWER PLANT
WELDED JOINT FOR HIGH-PRESSURE PIPING
HOPPER CARS FOR THE N. & W. R. R.
ALL-WOOD HOPPER CARS
RAIL CREEP
TRAIN RESISTANCE DUE TO WATER SCOOPING
SOLIDIFICATION IN RAILROAD VALUATION
AIR PUMPS AND CONDENSERS
CONDENSERS WITH LARGE WATER-LEVEL VARIATION

For Articles on Subjects Relating to the War, see Aeronautics, Engineering Materials, Machine Tools, Munitions, Varia

Acoustics

THE DOPPLER EFFECT, A. E. Watson and G. H. Makey. *Flight*, No. 469 (no. 51, vol. 9), December 20, 1917, pp 1335-1338, 4 figs. Discussion of the Doppler effect and its application to the location of flying machines in the air. According to the Doppler principle, the pitch of a note as heard differs from the true pitch of the note as emitted by the source of the sound in accordance with one or both of the factors, namely, relative movement between the source and the medium of oscillations, and relative movement between the observer and the medium. In the present article is examined only the case in which there is relative movement between the source and the medium. This applies particularly to the case of the observer being stationary in the air or on the ground while the note is coming from an aeroplane moving through the air.

Aeronautics

AIRPLANE DOPES, Gustavus J. Esselen, Jr. *The Journal of Industrial and Engineering Chemistry*, vol. 10, no. 2, February 1, 1918, pp. 135-137.

THE DESIGN OF AIR TURBINES, Alexander Klemin and Edward P. Warner. *Aviation and Aeronautical Engineering*, vol. 4, no. 1, February 1, 1918, pp. 19-22, 7 figs.

THE 230-H.P. BENZ AERO ENGINE. *Aeronautics*, vol. 13, no. 218 (New Series), December 19, 1917, pp. 476-490, 37 figs.

THEORY OF BOMB DROPPING. *Aviation and Aeronautical Engineering*, vol. 3, no. 12, January 15, 1918, pp. 819-822, 11 figs.

ITALIAN NAVAL AIRCRAFT. *The Engineer*, vol. 125, no. 3236, January 4, 1918, pp. 6-8, 6 figs.

STANDARD AERO-ENGINE PRODUCTION. *Engineering*, vol. 105, no. 2715, January 4, 1918, pp. 13-14. An editorial discussing the advantages and disadvantages of standardization in the production of aeronautical engines. The writer is inclined to believes that more standardization should be applied in British production.

TESTING MACHINES FOR AEROPLANE MANUFACTURE. *Engineering*, vol. 105, no. 2714, January 4, 1918, pp. 1-4, 14 figs.

Air Engineering

HOW TO USE A PSYCHROMETRIC CHART, J. I. Lyle. *The Heating and Ventilating Magazine*, vol. 15, no. 1, January 1918, pp. 33-36, 1 fig.

Engineering Materials

TESTS OF SLAG CONCRETE. A series of tests for the purpose of comparing slag, gravel and stone as the coarse aggregates for concrete is being carried on by the Pittsburgh Testing Laboratory, Pittsburgh, Pa., it being the intention to extend the tests over a period of five years. The tests made up to the end of the first six months have now been made public.

The fine aggregate is sand from the Ohio River, while the coarse aggregates cover nine varieties of slag gathered from plants in various parts of the country, two kinds of gravel, two kinds of limestone, a trap rock and a crushed granite. The proportions were determined by establishing the leanest mixture which would produce a dense concrete when using the coarse aggregate having the highest percentage of voids and then using the mixture for all the materials. This led to the use of proportions of one part cement, two parts sand and four parts of the coarse aggregate. The specimens were kept in molds for 48 hr. and were then stored in damp sand for 35 days, after which followed storage in air. Four short pieces of reinforcing steel were imbedded in each of two cylinders from every batch for the determination of the corrosive tendencies. The results shown in Table 1 were obtained. (*Railway Age*, vol. 64, no. 3, January 18, 1918, pp. 165-166, *e*)

TABLE 1 RESULTS OF COMPRESSION TESTS ON 8-IN. BY 16-IN. SLAG-CONCRETE CYLINDERS

Character of coarse aggregate used	Compressive Strength in Pounds per Square Inch											
	14 days			30 days			60 days			180 days		
	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
Gravel	2093	1792	1921	2608	2040	2294	3427	2378	2925	4200	3404	3798
Limestone	1840	1720	1758	2442	1950	2174	3846	3014	3343	5011	3814	4426
Trap rock	2109	2026	2063	2454	2330	2386	3416	3256	3360	4906	4738	4819
Granite	2208	1980	2122	2334	2230	2292	3258	2760	3043	4248	4016	4151
Slag No. 1	2594	2380	2484	3127	2999	3075	3460	3268	3365	4906	4678	4803
Slag No. 2	1998	1897	1941	2770	2343	2525	3008	2815	2930	3958	3560	3753

FIRE TESTS OF BUILDING COLUMNS, Noeman F. Kimball. *The Armour Engineer*, vol. 10, no. 2, January 1918, pp. 107-116, 2 figs. Description of tests carried out at the Underwriters Laboratories in Chicago for the purpose of determining the ultimate fire resistance of large building columns and the fire-resistive value of various kinds of column protection. No actual results of the tests are reported.

The Setting of Cement and Plasters. *Engineering*, vol. 105, no 2716, January 18, 1918, pp. 71-73. To be continued.

Rate of Application of Load on Compressive Strength of Concrete, D. A. Abrams. A discussion of the different rates of loading as affecting the results obtained from precision tests of concrete.

Among the conclusions at which the writer arrives is that for the richer mixes (1:5 and 1:3) tested at the age of 28 days, the strength when loaded at 0.15 in. per min. is 14 to 20 per cent higher than when loaded at 0.006 in. per min.

If part of the load is applied at a fast speed and the remainder at a slow speed, the ultimate strength of the concrete is not changed, even though as much as 88 per cent of the total load is applied at the fast speed.

Knowing the approximate strength of the specimen, it will greatly expedite the work of testing and involve no sacrifice in accuracy, if we apply, say, 50 to 75 per cent of the ultimate load at a fast speed before changing to the slow speed.

A machine speed which gives a shortening of the test piece of 0.01 to 0.02 in. per min. per ft. of the length is recommended as a standard rate for compression tests of concrete.

The results show that the mean error of a group of tests

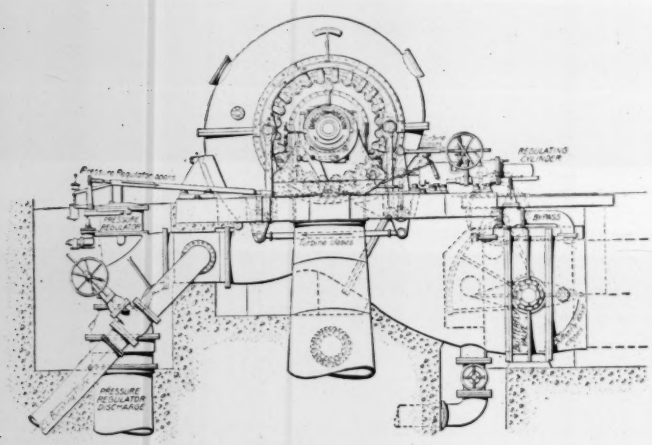


Fig. 1 25,000-Hp. Francis Turbine

made on the same day is considerably lower than that of a set of tests made on different days; while the mean error of the daily average compressive strengths is generally much higher than that of the average tests made on different days. (*Engineering and Cement World*, vol. 12, no. 2, January 15, 1918, pp. 33-36, 2 figs., 4 tables)

German-Made Boiler Tubes. When the former German liner *President Grant*, now *U. S. S. President Grant*, was being put through preliminary tests after the necessary repairs, it was found that her boiler tubes were defective. Samples of the tubes taken out were tested at the New York Navy Yard by Prof. William Campbell, who, by the way, did not know where the tubes were obtained.

Standard tests and microphotographs were made, and it was found that the German tubes were even poorer than such American tubes as have been previously rejected by the Navy. Mottling was found, presumably due to segregation of phosphorus, as well as abnormally coarse grain. Phosphorus contents of 0.263 were found, while the sulphur was about the same as in American tubes, or 0.018. Excessive brittleness was also discovered. (*Iron Trade Review*, vol. 62, no. 4, January 24, 1918, p. 274, *e*)

Firing

Automatic Combustion Control Saves Much Coal, I. L. Kentish-Rankin. *Engineering and Cement World*, vol. 12, no. 2, January 15, 1918, pp. 42-44, 1 fig.

Fuel

Gas Firing Boilers, T. M. Hunter. *The Journal of The Institution of Electrical Engineers*, vol. 56, no. 270, January 1918, pp. 57-91, 3 figs., 17 tables. A very interesting paper of which an abstract will appear in an early issue. The following subjects are discussed: Calorific value of gas; stability of gas for boiler firing; drying and cleaning; heat transfer; types of boilers, boiler draft, boiler settings; air leakage; radiation and conduction; combustion; practice; gas measurement, boiler control.

Nouvel Appareil de Fractionnement pour les Pétroles et Autres Produits Volatils, M. E. Hildt. *Comptes Rendus Hebdomadaires des Séances de L'Académie des Sciences*, tome 165, no. 23, December 3, 1917, pp. 790-793, 1 fig.

Furnaces

Gas Circulation in Regenerator Checkers, A. D. Williams. *The Blast Furnace and Steel Plant*, vol. 6, no. 1, January 1918, pp. 29-33, 7 figs.

Nouveau Type de Four Électrique à Acier sans Électrodes. *Journal du Four Électrique et de l'Électrolyse*, 26e Annee, no. 24, December 15, 1917, pp. 325-326.

Hydraulic Engineering

Largest High-Head Francis Turbine, Arnold Pfau, Mem. Am.Soc.M.E. Description of the hydroelectric equipment installed in the White River plant of the Puget Sound Traction Light and Power Company near Sumner, Washington. This plant contains two 18,000-hp. Francis turbines operating under a net head of 440 ft., which have developed over 44,000 hp. without any detriment to their efficiency.

In order to prevent excessive variations in speed and voltage of the power system it was necessary to use a very sensitive governor to quickly control the gates of the turbine. The sudden change in the flow of water through the pipe lines and tunnel would cause pressure variations which would not only impair the regulation, but might accelerate to such an extent as to wreck the whole plant.

The following methods of precaution are used:

1 A surge receiver at the end of the tunnel for the purpose of preventing surges set up by the tunnel from materially affecting the pressure in the pipe lines and vice versa.

2 Pressure regulators so combined with the turbines that they permit of a sudden release of the water, which is brought to a stop when the governor closes the gates of the turbines quickly.

3 Air-cushioned tanks which supply hydraulic energy to the turbines when the demand of load is so sudden that the water cannot accelerate in the pipe line sufficiently fast to prevent a serious drop in pressure.

The proper combination of these devices, together with a liberal flywheel effect of the revolving parts of the generators, is said to have made it possible to attain a high accuracy of speed regulation.

The pressure regulator details are shown in Fig. 1. The regulator is directly connected to a branch pipe provided on the lower portion of the spiral casing. It consists of an elbow

with the circular disk valve opening and discharging water downwardly through the plain steel pipe into the tail race. The disk valve is connected to a piston subjected to water pressure controlled by a regulating valve, which in turn is relay operated from a direct connection to the turbine gates. The oil dashpot is so inserted into this connection that the motion of the turbine gates is transmitted to the regulating valve only when the governor closes the former quickly, the slow motion only being completely absorbed in the dashpot. Thus the discharge of the turbine can be quickly switched over from the turbine to the pressure regulator, and there reduced slowly in accordance with the setting of the bypass in the oil dashpot determining the rate of the closing motion.

The governor is installed on a special stand containing the flyballs and the relay of the governing device. The oil pressure is obtained from a central oil-pressure system located in the basement of the plant and is produced in the pumps of a rotary-gear type. The governor has a capacity of about 50,000 ft-lb., and is capable of moving the turbine gates over their full stroke in one second.

In a test the full load of 20,000 hp. was thrown off suddenly, causing the governor to close the gates quickly. The speed did not rise more than 12 per cent above normal, and the maximum pressure rise in the pipe line above normal did not exceed 5.5 per cent as against a guaranteed pressure rise of 15 per cent and a speed rise of 18 per cent. (*Power*, vol. 47, no. 6, February 5, 1918, pp. 174-177, 6 figs., *d*)

VERIFICATION OF THE BAZIN WEIR FORMULA BY HYDRO-CHEMICAL GAUGINGS, Floyd A. Nagler. *Proceedings of the American Society of Civil Engineers*, vol. 44, no. 1, January 1918, pp. 3-54, 24 figs., 4 tables, 1 plate.

SUR LA DÉTERMINATION DES DIMENSIONS LES PLUS AVANTAGEUSES DES PRINCIPAUX ÉLÉMENTS D'UNE INSTALLATION DE FORCE HYDRAULIQUE, E. Baticle. *Comptes Rendus des Séances de l'Academie des Sciences*, vol. 165, no. 25, December 17, 1917, pp. 995-997.

Internal-Combustion Engineering

GAS PRODUCER WITH FLOATING AGITATOR. In a gas producer recently developed by the Chapman Engineering Company, of Mount Vernon, Ohio, a floating agitator is provided to stir up the fuel bed. The purpose of this device is to prevent the formation of clinkers by destroying blowholes and hot spots in the fuel bed.

It is claimed also that the agitator eliminates hand poking, as well as increases the capacity of the producer and the quality of the gas because of the frequent stirring of the entire surface of the firebed.

The agitator, Fig. 2, is built of heavy seamless tubing, the cross-arms being provided with stirring fingers of high-carbon steel. Cooling water is carried to the end of each finger by an inner tube. If desired, steam can be used for blowing on the fingers. The agitator passes through the fuel bed at the rate of five revolutions per hour. Motor drive is employed, the power being transmitted to a worm and wormwheel running into it.

The vertical or floating movement of the agitator resembles, on a large scale, the combined movement of a Yankee screwdriver. The vertical shaft of the agitator has a spiral driving head, with two large, screwlike spiral flanges that engage in sliding contact with two lugs projecting inwardly from the driving-wheel hub. Under ordinary conditions the wheel with the agitator revolve together, but if an obstruction is encountered, or the agitator becomes submerged too deeply in the surface of the firebed, it automatically screws up at once to a point where the forces are again in balance. (*The Iron Age*, vol. 101, no. 6, February 7, 1918, p. 385, 1 fig., *d*)

CENSUS OF INTERNAL-COMBUSTION ENGINES. The *National Gas Engine Association Bulletin* has just made public data on the 1914 census of internal-combustion engines.

From this census it appears that in 1914 there were 809 establishments which reported the manufacture of engines, of which 243 made steam engines, 549 made internal-combustion engines and 52 made waterwheels, motors and turbines.

As regards internal-combustion engines, the great bulk of the engines produced were rated at having less than 50 hp. and less than 2 per cent as having more than 50 hp. More than nine-tenths of these engines had less than 10 hp. (*N. G. E. A. Bulletin*, vol. 3, no. 7, February 1918, pp. 2-4, *s*)

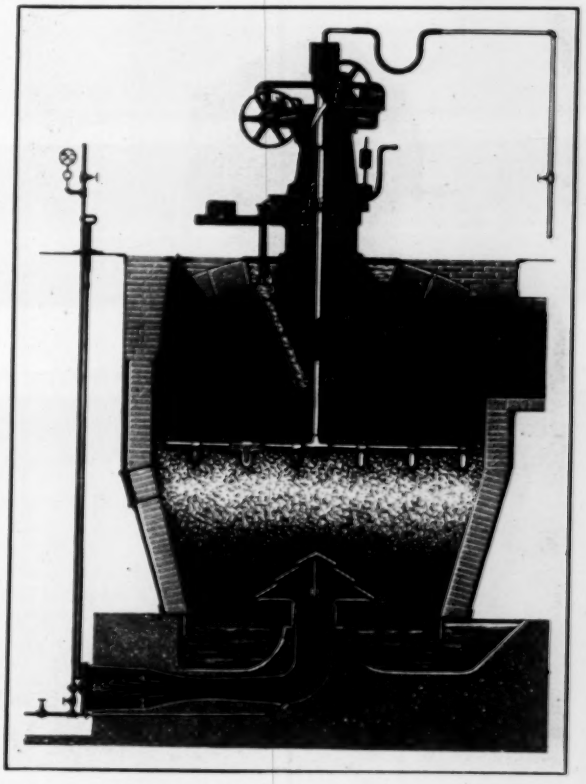


FIG. 2 GAS PRODUCER WITH FLOATING AGITATOR

THE ARMOUR INSTITUTE OF TECHNOLOGY INTERNAL COMBUSTION ENGINE ENGINEERING LABORATORY, Daniel Roesch. *The Armour Engineer*, vol. 10, no. 2. January 1918, pp. 102-106, 6 figs. Description of the new unit-type laboratory at the Armour Institute of Technology.

THE ESCAPE OF EXHAUST GAS IN TWO-STROKE-CYCLE ENGINES, Guy B. Petter. In a two-stroke-cycle engine it is necessary to know the time required for the exhaust pressure to fall from its initial value to the atmospheric. Engines of the type referred to have inlet and exhaust ports in the cylinder wall which are uncovered by the piston toward the end of its outward stroke. The exhaust ports are given a "lead" so that the exhaust may get away by the time that the air ports open.

The velocity of escape of exhaust gas through the exhaust ports is affected with many uncertainties, and especially with the contraction of the gas by cooling. As, however, we wish

to establish a formula for purposes of comparison only, we assume that the fall of pressure is due entirely to the escape of gas through the exhaust ports at constant velocity.

Let v = constant velocity, in. per sec.

p = pressure (absolute) at the instant t (in seconds) reckoned from the moment of exhaust opening, lb. per sq. in.

V = capacity of cylinder and cylinder head above piston when the exhaust ports begin to open, cu. in.

A = area of exhaust ports open at the instant t, sq. in.

b = total width of exhaust ports, in.

m = engine speed, deg. per sec.

a = crank throw, in.

c = connecting-rod length, in.

e = line joining crankshaft center to gudgeon pin, in.

Values with the suffix o are for initial conditions when the exhaust ports begin to open, and valves with the suffix f are for final conditions when atmospheric pressure is reached. It

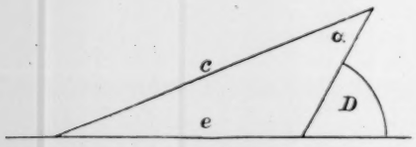


FIG. 3 EXHAUST PORT OPENING DIAGRAM

will be noted that p_f is atmospheric pressure in absolute units.

The total quantity of gas escaping is

$$\frac{p_o - p_f}{p_f} V$$

The quantity of gas escaping in a small interval $\triangle t$ at the instant t is

$$\frac{p}{p_f} vA\triangle t$$

and

$$\frac{p_o - p_f}{p_f} V = \int_{t_o}^{t_f} \frac{p}{p_f} vA\,dt \quad \ldots\ldots\ldots\ldots [1]$$

Assuming from the evidence of the indicator card that the fall of pressure is directly proportional to the time, we write

$$p = p_o - \frac{(p_o - p_f)t}{t_f} \quad \ldots\ldots\ldots\ldots [2]$$

Also, we may write with sufficient accuracy

$$A = \frac{A_f}{t_f} t \quad \ldots\ldots\ldots\ldots [3]$$

Then we shall have

$$\frac{p_o - p_f}{p_f} V = \int_{t_o}^{t} \frac{p_o t_f - (p_o - p_f)t}{p_f t_f} v \frac{A_f}{t_f} t.dt \quad \ldots\ldots [4]$$

Integrating and applying the limits, we have

$$\frac{p_o - p_f}{p_f} V = vA_f \left[\frac{p_o}{p_f t_f} \cdot \frac{t^2_f}{2} - \frac{p_o - p_f}{p_f t^2_f} \cdot \frac{t^3_f}{3} \right] \quad \ldots\ldots [5]$$

or

$$V = \frac{vA_f t_f (p_o + 2p_f)}{6(p_o - p_f)}$$

Consider the triangle in Fig. 3, formed by the crank a, the connecting rod c and the line e from the crankshaft center to the gudgeon pin. Neglecting the obliquity of the connecting rod, the depth of the exhaust-port opening at the instant t is $a(\cos D - \cos D_o)$ where D is the angle of the crank before dead-center position at the instant t, and D_o is the angle at the instant of exhaust-port opening.

Then

$$D_o = D - mt, \text{ or } D = D_o - mt \quad \ldots\ldots\ldots [6]$$

And

$$A_f = ab \left\{ \cos (D_o - mt_f) - \cos D_o \right\} \quad \ldots\ldots\ldots [7]$$

Therefore

$$V = vabt_f \frac{p_o + 2p_f}{6(p_o - p_f)} \left\{ \cos (D_o - mt_f) - \cos D_o \right\} \quad \ldots [8]$$

From [8] we can compute v if t_f is known or t_f if v is known. The solution for t_f is best found graphically from the intersection of the curves

$$y = \frac{6(p_o - p_f)V}{vabt_f (p_o + 2p_f)} \quad \ldots\ldots\ldots\ldots [9]$$

and

$$y = \cos(D_o - mt_f) - \cos D_o \quad \ldots\ldots\ldots\ldots [10]$$

It is not to be supposed that these results will be physically correct, but they will serve for purposes of comparison. A mean value of v under ordinary working conditions can be obtained with the indicator card of any well-designed engine, taking t_f from the card and v from [8]. For the Petter crude-oil engine it is found to be in the region of 1650 ft. per sec. With this value of v it is easy to determine from Equation [8] suitable values for the width and lead of the exhaust ports. The relation

$$e^2 = c^2 - a^2 - 2ae \cos D$$

enables the position of the piston to be found for any crank angle D. (*Engineering*, vol. 105, no. 2714, January 4, 1918, p. 7)

350-B.HP. KROMHOUT MARINE ENGINE. Description of the largest Kromhout marine-type engine yet built. The general principles of construction of these engines were described in THE JOURNAL (January 1914, p. 022).

This engine, built in Amsterdam, Holland, operates on the two-stroke cycle, having four cylinders of 16¾-in. bore by 18¾-in. stroke, and develops its full power at about 240 r.p.m.

Starting and reversing of the engine is effected by means of compressed air. Referring to Fig. 4, the camshaft E is carried on the front of the engine, two cams being fitted for each cylinder to operate the air-starting and reversing valves. In addition, the camshaft has four cams for operating the four feed pumps. This camshaft is operated by the hand-wheel A by means of which a shaft can be moved in a fore-and-aft direction with the engine either stationary or running, the cams being so arranged that the movement of the shaft with the engine stationary admits compressed air for starting to the cylinder in the best position for commencing the rotation of the engine in the required direction, that is, to go ahead or astern. The engine has no dead center, but will start from any position, either ahead or astern. Air is admitted to the requisite cylinder through the valves G, the jackets of which are water-cooled, and immediately above each valve is mounted a small horizontal cone valve for indicating purposes.

The stroke of the fuel feed pumps and consequently the revolutions of the engine are regulated by the hand wheel D with the shaft operated by this lever being also connected to the governor F, so that the strokes of the fuel feed pumps are adjusted as required by the governor in the event of the load being suddenly taken off for any reason. The hand-wheel D operates a friction clutch used for disconnecting the propeller shaft from the engine when the signal "stop" is telegraphed down from the navigating bridge. The governor

then automatically comes into action and reduces the stroke of the fuel feed pump as necessary, so that the engine runs at about 100 r.p.m., at which speed the cylinder vaporizers remain at the proper temperature to keep the engine running and in definite time.

The governor *F* has several functions. It controls the revolutions per minute of the engine in two ways: first, as described, by reducing the pump stroke. At the same time, however, it throttles the scavenging in order to maintain the required temperature in the combustion chamber. It has also one particular advantage and that is, when the engine at sea is running at normal full speed of 200 r.p.m. and the propeller heaves out of the water, the governor at once prevents any tendency to racing.

The handwheel *J* enables the engineer to adjust the quantity of scavenging air in relation to the engine speed. There are also manual means for regulating the quantity of circulating water per cylinder, safety valves being provided to prevent any damage to the pumps should all four control valves be closed down inadvertently at the same time.

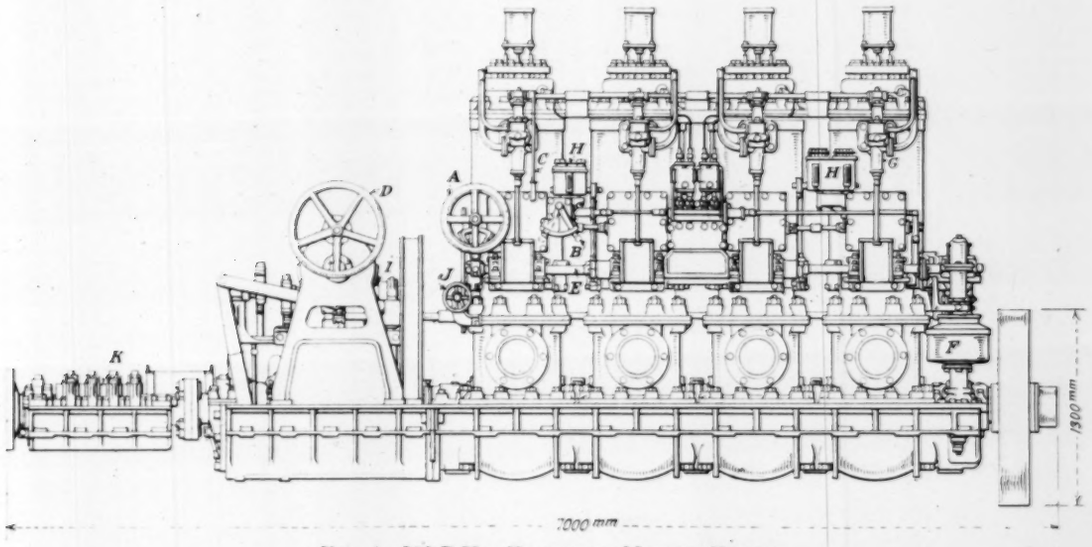


FIG. 4 350-B.HP. KROMHOUT MARINE ENGINE

A special receptacle for methylated spirit is provided for the preliminary heating of the lamps: namely, a deep cup with a long handle which can be conveniently filled without danger of spilling, put into position and lit up without any chance of the spirit overflowing if the ship is rolling heavily.

The vaporizing arrangements are such that blow lamps are required for starting purposes only. Once the engine is running it will continue to do so at any revolutions between 100 and 240 for any length of time, and will pick up the full load immediately, even after running at the lowest number of revolutions for several hours. This is achieved simply by the fact that the quantity of scavenging air is always proportionate to the revolutions per minute. The engine requires no water injection.

An auxiliary set is supplied with each unit to drive the air compressor and possibly also the dynamo and bilge and ballast pumps. It is usually constructed on the same principle as the main engine, but without the reversing gear. (*The Engineer*, vol. 125, no. 3237, January 11, 1918, pp. 36-37, 3 figs., *d*)

Machine Shop

TAPPED HOLES. *The Automobile Engineer*, vol. 8, no. 110, January 1918, p. 11.

GENERATED GEAR TEETH, Trevor Rapson. *The Automobile Engineer*, vol. 8, no. 110, January 1918, pp. 2-6.

THE MAKING OF PLUG AND RING GAGES, J. H. Smith. *American Machinist*, vol. 48, no. 5, January 31, 1918, pp. 191-193, 6 figs.

INTERCHANGEABILITY, TOLERANCES AND FINISH, J. P. Brophy. *American Machinist*, vol. 48, no. 4, January 24, 1918, pp. 156-157.

Machine Tools

LARGE CRANK PIN TURNING MACHINE. *The Engineer*, vol. 125, no. 3238, January 18, 1918, pp. 50-52, 6 figs.

THE EVOLUTION OF A HIGH SPEED STEEL TOOL, J. T. Thorne. General discussion of the manufacture of high-speed tool steel, with brief reference to the influence of impurities and heat-treatment. The following statement is of particular interest: "High-speed steel instead of being a tough, inert material, as many people suppose, is rather to be compared to a finely balanced piece of machinery and is swung this way or that by the various influences it undergoes in the process of heat-treating." (*Proceedings of the Steel Treating Research Society*, vol. 1, no. 5, December 1917, pp. 4-19, 12 figs.)

Mechanics

FLYWHEEL DESIGN FOR ROLLING MILLS, G. E. Stoltz. The intermittent character of the rolling-mill load makes it necessary to have adequate flywheel capacity to equalize the power requirements and avoid heavy momentary overloads on the driving unit. The use of a proper flywheel effect permits, in certain cases, the installation of driving and generating equipment designed to carry a load of practically a constant character. Better overall economy is obtained, although the friction loss of the flywheel is added.

The writer discusses in brief the theory of flywheels.

The location of the flywheel is of importance. Logically, the flywheel should be placed as near the load as possible, but in some applications, such as sheet mills, this is not feasible as the mill speed is too slow. To properly equalize

the load on an 8-stand mill with the flywheel operating on the mill shaft at 30 r.p.m., a flywheel of 350 tons weight would be required. This is not practical, and on engine-driven mills, even with a comparatively large engine but a moderate-sized wheel, the engine does not fully compensate for lack of flywheel capacity, with the result that the speed drops considerably when peak loads are obtained. With electric drive the motor is usually operating at about 240 r.p.m. and a herringbone-gear unit is provided to obtain the proper mill speed. The flywheel capacity is usually obtained by placing the flywheel at each end of the pinion shaft. By doing this the total weight of the wheels would be 30 tons to provide the same flywheel effect as would be obtained if a 350-ton wheel were placed on the mill shaft. This has the disadvantage of transmitting all the peaks through the gears, but is the practical solution for this type of drive. Where sheet-mill engines have been replaced by motors with adequate flywheel effect, the monthly output may be increased approximately 10 per cent, which is due to the elimination of periods when the mill is slowed down sufficiently to interfere with its operation.

The conditions in the case of a blooming mill were investigated. The mill was of the three-high type, 28-in., operating at 70 r.p.m. Among other things, the writer calls attention

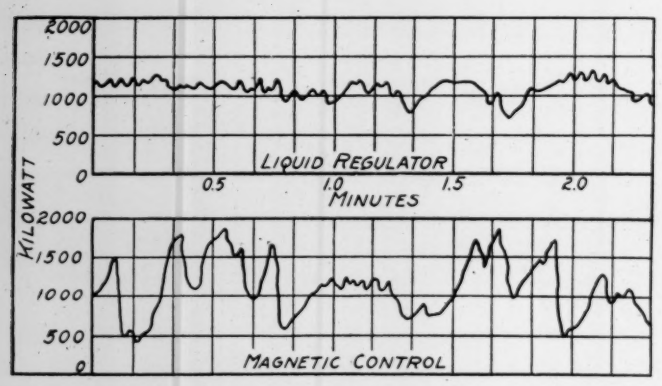


FIG. 5 COMPARATIVE WATTMETER CURVES ON SHEET MILL

to the fact that it is important to take under consideration the type of control used, as some utilize the flywheel effect to a better advantage than others.

From this point of view Fig. 5 is of interest. It refers to a sheet mill and shows the kilowatt input with notching in relays which regulates the amount of grid resistance of the secondary circuit of the motor, while the other curve is taken with the liquid slip regulator in the secondary circuit. The flywheel effect is the same, but the regulator does not come into action until the motor is fully loaded. With grid resistance in the secondary of the motor the flywheel and motor slow down in direct proportion to the load and when full load on the motor is obtained, the flywheel may be operating at 15 per cent slip and any further peak load cannot be absorbed by the flywheel to the same extent as when at its full speed. (*Iron Trade Review*, vol. 62, no. 4, January 24, 1918, pp. 272-274, 3 figs., *pe*)

SOLUTION OF PROBLEMS OF TORSION BY THE USE OF SOAP FILMS, A. A. Griffith and G. I. Taylor. The equations which represent the torsion of an elastic bar of any uniform cross-section are of exactly the same form as those which represent the displacement of a soap film due to a slight pressure acting on its surface, the film being stretched over a hole in a flat plate of the same shape as the cross-section of the bar. Hence, by making appropriate measurements of soap films it may be possible to find the stresses and torsional stiffness of a twisted bar or shaft of any cross-section whatsoever.

Torsional problems are of great importance in aeronautical calculations. Propeller blades, spars, struts, etc., are subject to torsion, and at the same time have to be made of complex sections. It is therefore important to know the torsional stress occurring in them, so as to be able to use the minimum of material. The writers have developed a very simple experimental method for solving these problems.

A hole is cut in a thin plate of the section required to be investigated and a circular hole of a predetermined diameter is cut alongside it. The plate is placed in a box and soap films are stretched across the holes. The films are blown out slightly by reducing the air pressure on one side of them. By making suitable measurements of the shape of the resulting film surfaces it is possible to find the stresses in a bar of the given section in terms of the stresses in a circular bar of the same diameter as the circular hole when the two bars are twisted through the same angle per unit of length. By means of other measurements it is equally easy to find the ratio of the torques which must be applied to the two parts in order to produce the same twist in both.

In order to apply this method, apparatus is required with which three kinds of measurements can be made:

1 Measurements of the inclination of the film to the plane of the plate at any point for the determination of stresses. Optical reflection apparatus is used, the image of an electric-lamp filament being used in the film in such a way that the reflection ray is coincident with the incident ray, so that their common direction gives the inclination of the normal to the surface of the film.

2 Determination of the contour lines of the film. For mapping these lines a steel needle, point, moistened with soap solution, is arranged to move about over the plate, its distance therefrom being adjustable by means of a micrometer screw. The point is made to approach the film until the distortion of the image in the latter shows that contact has occurred. This method of mapping contours is referred to here as the "spherometer" method.

3 Comparison of the displaced volumes of the test film and circular standard for finding the corresponding torque ratio. This is done by blowing the films up by running a known volume of water, or preferably soap solution, into the apparatus from a pipette.

The apparatus consists, therefore, of this spherometer for mapping the contour lines and the auto-collimator for determining the inclination of the film, this determination being usually confined to the determination of inclinations at given points on the boundary which are marked by scratches on the plate. For stress measurements the auto-collimator method is better than the contour-line method since it gives the inclination directly, whereas in the other case the inclination can only be found by a graphical determination.

Investigation of torsion problems by the soap-film method was checked by experiments of wooden beams of the same section. In one of these experiments a walnut plank was shaped so that its section was exactly the same as the hole in one of the test planes which represented a section in a propeller blade of fineness ratio 10.55, having its thickest part about one-third of the way from the leading edge. The value of the modulus of rigidity M was found by performing a torsion test on this plank, using the expression for the torque given by a soap-film experiment on the plate which was used in shaping the plank. N was found to be 0.1355×10^6 lb. per

sq. in. Five circular holes were then cut in the plank and their rigidities were measured. The mean value of N found in this way was 0.1387×10^6, or a difference of only 2.3 per cent.

When contour lines have been mapped the torque may be found from them by integration. If the graphical work is carefully done the value found in this way is rather more accurate than the one obtained by the volumetric method. Contours may also be used to find stresses by differentiation, that is, by measuring the distance apart of the neighboring contour lines: but here the comparison is decidedly in favor of the direct process, owing to the difficulties inseparable from graphical differentiation. The contour map is nevertheless a very useful means of showing the general nature of the stress distribution throughout the section in a clear and compact manner. The highly stressed parts show many lines bunched together, while few traverse the regions of low stress, and the direction of the resultant stress is shown by that of the contours at every point of the section. Furthermore, the map solves the torsion problem, not only for the boundary, but also for every section having the same shape as a contour line.

With the aid of simple apparatus of this kind the truth of theorems such as those contained in the following list may be readily demonstrated.

a The stress distribution—and therefore the torque—for any section is independent of the axis of twist. This is easily seen, since the shape of the soap film is completely determined by the boundary and the value of $4S/p$. Hence the torque on a number of bars clamped together at their ends may be found by adding the separate torques which would be necessary to twist each through the same angle. This, as in other cases, applies to torque only. It will be realized that in practice there will be bending stresses which must be taken account of in the usual way.

b Any addition of material to a section must increase the torque, and vice versa, so long as the distribution of material in the original section is unaltered.

c Any cut made in a section, whether it decreases the area or not, must decrease the torque.

d The stress at any point of the boundary of a section is never less than the boundary stress in a circular bar under the same twist, and whose radius is equal to that of the circle inscribed in the section which touches the boundary at the point in question.

More generally, if one section lie entirely inside another so as to touch it at two or more points, the stresses in the inner figure are less than those in the outer one at the points of contact; if the two figures are approximately congruent in the neighborhood of the points of contact, the difference between the stresses is small. The maximum stress in a section is not greater than $2aNr$, where a is the radius of the largest inscribed circle, unless the boundary is concave, that is, reëntrant.

e If a concave part of the boundary approximates to a sharp corner, the stress at this point may be very high, and if the curvature is infinite when the stress is also theoretically infinite, whatever be the situation of the corner with respect to the rest of the section. Actually, of course, if the material is ductile, we can only deduce that the stresses at such a corner are above the elastic limit.

f It is a consequence of (*e*) that it does not necessarily follow that the making of a cut in a section will reduce its strength, whether material is removed or not. As an example of this, one may quote the case of an angle iron in which the internal corner is quite sharp. It is well known in practice that this will often fracture. It may be strengthened, however, by reducing the section, planing out a semicircular groove at the root of the angle iron.

g There can be no discontinuous changes of stress anywhere in a section, excepting only those parts of the boundary where the curvature is infinite—concave or convex sharp corners.

h The maximum stress occurs at or near one of the points of contact of the largest inscribed circle, and not, in general, at the point of the boundary nearest the centroid, as has been hitherto assumed. An exception may occur, if, at some other part of the boundary, the curvature is—algebraically—considerably less; that is, the boundary is more concave than it is at this point.

i If a section which is long compared with its greatest thickness be bent so that its area and the length of its median line are unchanged, its torque will not be greatly changed thereby. For instance, the torsional stiffness of a metal plate is practically unaltered by folding or rolling it up into the form of an L or a split tube. Soap-film experiments show, in fact, that there is a diminution of less than 5 per cent when the inner radius of the boundary is not less than the thickness at the bend.

j The "unstressed fiber," which is situated at the point corresponding with the maximum ordinate of the soap film, is near the center of the largest circle which can be inscribed in the section.

In general, the inscribed circle has a maximum value wherever it touches the boundary at more than two points, and there is usually an unstressed fiber near the center of each of these circles. Between each pair of maximum ordinates on the soap film, however, there is a "minamax" point, which is near the center of the corresponding minimum inscribed circle. This fiber in the bar is also unstressed.

k The "lines of shearing stress" round the unstressed fibers of the first sort are initially ellipses, and round those of the second sort hyperbolas, from which shapes they gradually approximate to that of the boundary. Notions of this sort are useful in practice, because it is possible, with their help, to sketch in the general nature of the lines of shearing stress for any section.

The rest of the paper is devoted to the discussion of approximate formulæ for torques and stresses, and concludes with a mathematical appendix. Those who desire to follow the matter further will do well to refer to the original. (*Engineer*, vol. 124, no. 3234, December 21, 1917, pp. 546-547, 2 figs., *e.A*)

Mechanics

THE LATERAL VIBRATIONS OF BARS OF VARIABLE SECTION, J. W. Nicholson. *Proceedings of the Royal Society*, vol. 93, no. A 654, September 1, 1917, pp. 506-519.

LAMINATED STEEL-SPRING PROPORTIONS, H. H. Kennedy. *American Machinist*, vol. 48, no. 5, January 31, 1918, pp. 182-183.

CIRCULAR-ARC BOW-GIRDER, William Knight. *Engineering*, vol. 105, no. 2716, January 18, 1918, pp. 55-57, 12 figs.

Measurements

THE AUTOMATIC CONTROL AND MEASUREMENT OF HIGH TEMPERATURES, Richard P. Brown. From his experience in this country the writer claims that for industrial service an

instrument actuated by the expansion of nitrogen gas is the most satisfactory for temperature measurement up to 800 deg. fahr.

This instrument consists of a bulb of copper which is inserted in the heat and is connected by capillary tubing to an indicating or recording gage containing a helical expansive spring. The expansion of the gas in the bulb exerts a pressure in the capillary tubing which is conveyed to the spring in the instrument and the pointer attached directly to this spring moves across the scale or chart.

The writer discusses other instruments, such as thermoelectric pyrometers for use in measuring moderate temperatures where the measuring instrument must be placed at a considerable distance, or for measuring temperatures above the range of the gas-expansion instrument.

The writer has developed a new instrument which he calls the Brown heat meter and which is claimed to give greater precision in temperature measurements than is secured with the high-resistance millivoltmeter.

In this instrument, in addition to the standard high-resistance millivoltmeter, is used an ordinary dry cell about 1¼ in. in diameter by 2½ in. long, and a suitable rheostat to reduce the voltage of the dry cell from approximately 1½ volts to a range from 0 to 60 millivolts, the voltage produced as a maximum by the thermocouples. In the operations adjustments are first made to insure that the voltage developed by the thermocouple is equal to the reduced voltage of the dry cell. Then the voltage of the thermocouple is cut out and the voltage of the dry-cell circuit read by direct deflection, which eliminates the line resistance entirely, just as a potentiometer gives a deflection indicating the actual temperature developed by the thermocouple at the moment of reading the instrument. It does not, however, indicate the fluctuation in temperature of the thermocouple, since it is the voltage from the dry cell that is being read. It is possible, however, to get this reading by connecting the thermocouple to the meter of the dry-cell circuit and noting whether the indications are the same.

The writer also discusses in detail automatic temperature control and the design of a temperature-signaling pyrometer, which latter is an instrument which will automatically signal by lights whether the temperature is too high, correct, or too low in any particular furnace. (*Proceedings of the Steel Treating Research Society*, vol. 1, no. 5, December 1917, pp. 32-35.)

Munitions

SHELL MAKING BY IMPROVED MACHINE AND METHODS. Description of a method developed in a small machine shop to manufacture shells. A company in Ohio undertook the manufacture of shells for the Belgian army. The orders soon outgrew the capacity of the plant and a small shop was leased in Buffalo. In this latter plant the company manufactured shells of the French type having a longer taper and designed according to metric measurements. This required the improvisation of special machinery. One of the most interesting problems was connected with the process of nosing these French-type shells. The usual process of placing the shell forging centered and rough-machined vertically face down under a hammer or press and swedging it under a die could not be applied in manufacture under French specifications because of the thinness of the metal.

To meet this difficulty R. J. Wehland developed a machine for applying the force perpendicularly to instead of along the axis of the curve. This machine consists essentially of a steam hammer with two dies and a movable carriage which feeds the shell between the dies and rotates it between strokes of the hammer. The lower die is rigid. The upper one is impelled against the shell with a 1-in. stroke at the rate of 125 times per minute.

The shell base is held in the block on the carriage or feeding machine. Rotation is induced by a compressed-air motor working through a small pinion to the large gear which rotates the clamping device by which the shell is held. This rotation is at a constant rate, the entire carriage being moved forward by means of a large handwheel until the nosing attains the form desired.

The hammering is perpendicular to the long axis of the shell, and the only force delivered along the axis of the shell is that forward movement on the table by which the carriage is moved forward by the handwheel when the shell is fed into the dies.

This nosing machine may be used in connection with a forging press, as well as with the steam hammer. (*The Iron Trade Review*, vol. 62, no. 6, February 7, 1918, p. 373, 1 fig., *d*)

GAGES AND GAGE MAKING FOR MUNITION PLANTS. (Prepared by the Library of the Engineering Societies.)

1913.—Inspection Gages for Remington Gun Parts, 1913. (*Amer. Mach.*, vol. 38, pp. 763-768.) Discusses the life of gages; describes counterbore gage, milling inspection gage and contour gage.

1915.—Machining Shrapnel Shells, 1915. (*Machinery*, vol. 21, pp. 638-639.) Detailed description of gages for British and American shrapnel shells.

1915.—Standardization of B. A. Screws, 1915. (*Mech. Engr.*, vol. 36, pp. 75-76.) Provisional conclusions reached by the Small Screws Sub-Committee of the Engineering Standards Committee, enabling the National Physical Laboratory to issue a list of dimensions which may be of service at the present juncture to persons using the screws and assist in obtaining interchangeable work.

1916.—Abbott, P. W., What's the Matter with Our Methods of Threading? 1916. (*Amer. Mach.*, vol. 44, pp. 173-175.) A study of the various elements entering into the production of good screw threads both internal and external; relates to accuracy in munition and other work.

1916.—Anderson, John R., Adjustable Limit Gage for Munition Parts, 1916. (*Amer. Mach.*, vol. 45, p. 339.) Illustrated description of a "bridge gage."

1916.—Baker, Donald, Manufacturing Parts of Type 80 Time Fuses, 1916. (*Machinery*, vol. 23, p. 297.) Gives details of gages used in testing and manufacturing fuse parts.

1916.—Bogart, F. H., Deceptive Working Limits on Munitions, 1916. (*Amer. Mach.*, vol. 45, pp. 1021-1023.) Analysis of working limits on various parts.

1916.—Booth, W. H., Limit Gage System in Principle and Practice, 1916. (*Mech. Engr.*, vol. 37, pp. 109-112.) Deals with design and materials of limit and screw gages; article written because the widespread interest in munitions has brought the question of limit-gage systems very much to the front.

1916.—Bogart, F. H., Production Gages, 1916. (*Amer. Mach.*, vol. 45, p. 1106.) Discusses their application to munition work.

1916.—Booth, W. H., Limit Gage Principles and Practical Applications, 1916. (*Canadian Machinery*, vol. 15, pp. 285-286, 343, 417-418.) On limit gages for various services, materials, designs, etc.; states that it is of interest in relation to munition work.

1916.—Colvin, Fred H., Caps and Base Plugs for Time Fuse, 1916. (*Amer. Mach.*, vol. 45, pp. 467-471.) Illustrated details of gages used.

1916.—Colvin, Fred H., Making Adapters for British Detonating Fuse, 1916. (*Amer. Mach.*, vol. 44, pp. 239-241.) Illustrated details of gages used for the adapters.

1916.—Colvin, Fred H., Making Copper Rifling Rings, 1916. (*Amer. Mach.*, vol. 44, pp. 678-679.) Shows a simple device for gaging ring used on the base of a shell to make it follow the rifling grooves in a gun.

1916.—Colvin, Fred H., Making Five Million Primers for Cartridge Cases, 1916. (*Amer. Mach.*, vol. 44, pp. 309-315.) Shows illustrated details of gages used.

1916.—Colvin, Fred H., Making the British Time Fuse Mark 80-44, 1916. (*Amer. Mach.*, vol. 45, pp. 367-374, 421-425.) Describes and illustrates tools and gages for making time fuses.

1916.—Colvin, Fred H., Making the Small Parts of the British Time Fuse, 1916. (*Amer. Mach.*, vool. 45, pp. 549-553.) Gages used for different parts of the fuse are shown.

1916.—Colvin, Fred H., Making Top and Bottom Rings for Time Fuses, 1916. (*Amer. Mach.*, vol. 45, p. 513.) Describes a variety of special gages for fuse work.

1916.—Colvin, Fred H., Manufacturing British 8-in. Shells in 4½ Hours, 1916. (*Amer. Mach.*, vol. 44, pp. 749-754, 807-813.) Illustrated details of gages used.

1916.—Colvin, Fred H., Manufacturing 120-mm. Serbian Shells, 1916. (*Amer. Mach.*, vol. 44, pp. 397-403, 453-458.) Details of the gages used, and of turning shells by power to try the gages.

1916.—Darling, H. M., Adjustable Limit Gage for Munitions Parts, 1916. (*Amer. Mach.*, vol. 45, p. 969.) Describes gage for testing straightness of small-size twist drills.

1916.—Darling, Herbert M., Making Accurate Templets (letter), 1916. (*Amer. Mach.*, vol. 44, p. 865.) Method for gaging the form of shells.

1916.—Dowd, A. A., Making Gages for Shrapnel Shells, 1916. (*Iron Trade Review*, vol. 59, pp. 17-20.) Economics for gage manufacture; examples of gages.

1916.—French Screw Gage, 1916. (*The Engineer*, vol. 122, p. 234.) Describes and illustrates a simple form of screw gage devised by M. Marre; relates to the adoption of the S. I. screw thread by the French Minister of War.

1916.—Glazebrook, R. H., Limit Gages, 1916. (*Engrg.*, vol. 102, pp. 224-225, 240-242, 236-238 and 252-254.) Illustrated article subdivided into gages for plain cylindrical work, screw gages, form, and position gages. States that the importance of subject has grown since the commencement of the war.

1916.—Lavender, J. H., Some Notes on Hardening Screw Gages, 1916. (*Engrg.*, vol. 102, p. 631.) Particulars obtained from experimental work extending over a period of six months.

1916.—Hamilton, Douglas T., Gaging and Inspection Methods, 1916. (*Machinery*, vol. 23, pp. 95-118.) The developments of interchangeable manufacture; the limit system and its advantages; difference between allowance, tolerance and limit; probable life of gages, etc.

1916.—Hamilton, Douglas T., Profile and Indicating Gages, 1916. (*Machinery*, vol. 23, pp. 208-219, 302-318.) Description of different types of gages working on the indicating principle which have been used with satisfactory results in the manufacture of munitions.

1916.—Hey, J., Two Gages for Use in Fuse Heads, 1916. (*Machinery*, vol. 8, p. 751.) Illustrated description of gages used in a British factory.

1916.—Loading Primer Bodies, 1916. (*Amer. Mach.*, vol. 45, p. 460.) Final assembling and gaging devices used for primers.

1916.—Manufacture of Mark II Gains for 18 Pdr. H. E. Shells, 1916. (*Canadian Machinery*, vol. 15, p. 277.) Describes gaging device.

1916.—Mawson, Robert, Making Bayonet Scabbards, 1916. (*Amer. Mach.*, vol. 44, p. 292.) Shows tension gage for bayonet scabbard.

1916.—Mawson, Robert, Making 1-lb. Cartridge Cases, 1916. (*Amer. Mach.*, vol. 44, p. 1032.) Illustrated details of gages for testing cartridge cases.

1916.—Mawson, Robert, Making the 18-lb. Cartridge Case, 1916. (*Amer. Mach.*, vol. 45, p. 381.) Shows details of the gages used.

1916.—Mawson, Robert, Making the 4.5-in. Howitzer Cartridge Case, 1916. (*Amer. Mach.*, vol. 45, p. 110.) Shows details of gages.

1916.—Mawson, Robert, Manufacturing the 1-lb. High-Explosive Shell, 1916. (*Amer. Mach.*, vol. 45, p. 158, 202.) Details of gages for screw-machine operations, for outside and inside threads, diameter and thickness of shoulder, length, and final test gage for shell diameters.

1916.—Mawson, Robert, Manufacturing 12-in. Shrapnel, 1916. (*Amer. Mach.*, vol. 44, pp. 537-542, 581-587, 625-630, 675-677.) Gives details of gages used; illustrated.

1916.—Mayoh, F. H., Gages in Modern Manufacturing Practice, 1916. (*Canadian Machinery*, vol. 15, pp. 307-308, 327-328, 364-365.) Illustrations in groups of a number of standard gages; includes gages for testing shrapnel-shell fuse rings.

1916.—Micrometer Limit Gage Attachment, 1916. (*Sci. Amer. Suppl.*, vol. 82, p. 325.) Brief description of "Apollo Mykarms," a small limit-gaging device invented and patented by a British government inspector.

1916.—Moore, J. H., Manufacturing Adapters for 18-lb. High-Explosive Shells, 1916. (*Amer. Mach.*, vol. 44, p. 413.) Illustrated details of gages used.

1916.—Olsen, L. E., Gage for Measuring Shrapnel, 1916. (*Amer. Mach.*, vol. 44, p. 412.) Gage illustrated has many advantages over the common saw-frame style or the vertical standard with pin-dropping device.

1916.—Pusep, Hugo F., Whitworth Thread-Gage Making, 1916. (*Amer. Mach.*, vol. 45, pp. 775-777.) Deals with precision gages for munition factories.

1916.—Screw Gages, 1916. (*The Engineer*, vol. 121, pp. 263-264.) Explains the necessity for accuracy in a gage, the errors which may occur in screws, and methods whereby these errors may be discovered and measured and avoided in future work. Abstract of paper written by the staff of the National Physical Laboratory; states that the screw gage plays a considerable part in munition work.

1916.—Shell-Test Scale, 1916. (*Amer. Mach.*, vol. 45, p. 173.) The purpose of the scale is to immediately indicate whether the shell is under or over the prescribed weight.

1916.—Suverkrop, E. A., Manufacturing British 18-Pounder High-Explosive Shells, 1916. (*Amer. Mach.*, vol. 44, pp. 495-499.) In the final government inspection shells are subjected to a very rigid examination in which all the gages previously employed are again made use of.

1916.—Training That Will Not Be Forgotten (editorial), 1916. (*Amer. Mach.*, vol. 45, p. 435.) Precision gage work on munitions.

1916.—Unification des Filetages, vis Mécanique, France, Adoption du Système International par le Service de L'artil-

lerie, Ministère de la Guerre, 1916. (*Bull. d'Encouragement pour l'Industrie Nationale*, vol. 126, pp. 74-110.) Describes standard for screw threads adopted by the Minister of War of France for use in the artillery service.

1916.—United States Munitions, the Springfield Model 1903 Service Rifle, 1916. (*Amer. Mach.*, vol. 45.) General specifications and barrel operations, pp. 635-646, 679-689, 725-734; sequence of operations, including details of gages used. Operations on the barrel and fixed stud, pp. 679-689; illustrations of gages used. Operations on the bolt, pp. 987-994, 1033-1040, 1079-1087; shows sequence of operations and details of the gages. Operations on the receiver, pp. 813-821, 859-866, 901-911, 945-956; includes details of gages; illustrated. Operations on the sleeve, pp. 1123-1131, illustrated details of the gages.

1916.—Viall, Ethan, Making 3-in. Russian Shrapnel in a Pump Shop, 1916. (*Amer. Mach.*, vol. 44, pp. 849-850.) Details of Russian shrapnel gages; illustrated.

1916.—Wright, M. S., Tolerance System and Metric Conversion Table, 1916. (*Amer. Mach.*, vol. 45, pp. 702-704.) Tables compiled to assist in work necessary on gun construction.

1917.—Alford, L. P., ed., Manufacture of Artillery Ammunition, 1917, N. Y., McGraw-Hill Book Co., Inc. Gives illustrated details of gages used.

1917.—Baker, Donald A., Gages for Time-Fuse Parts, 1917. (*Machinery*, vol. 23, pp. 1089-1096.) Problems in the manufacture of gages for Russian time fuses and methods by which they were solved.

1917.—Bogart, F. H., Method of Machining the "85" Fuse Body, 1917. (*Amer. Mach.*, vol. 46, pp. 721-723.) Details of machining operations; illustrations of special gages, etc.

1917.—Bogart, F. H., Suggestions Relative to the Manufacture of Parts to Limit, 1917. (*Amer. Mach.*, vol. 46, pp. 667-671.) On the use of limits and limit gages; steps involved; requirements for expressing dimensions; essential and non-essential dimensions; examples of wrong dimensioning, etc., in the production of munition parts.

1917.—Brooker, Arthur, Screw Thread Measurement, 1917. (*Engrg.*, vol. 103, pp. 113-118, 139-141, 165-166.) Definitions; method of measurement by microscope micrometer, diametral measurements by floating micrometer, optical projection apparatus, and measurement of pitch by mechanical means. Designed to be useful in manufacturing interchangeable parts in large quantities. (Same in *Mech. Engr.*, vol. 39, pp. 339-343, 353-355, and in *Post Office and Elec. Engrs. Jour.*, vol. 10, pp. 153-170.)

1917.—Buckingham, Earle, American Industrial Progress as Revealed by War Orders, 1917. (*Amer. Mach.*, vol. 46, pp. 315-321.) Contrasts American and European manufacturing development and then briefly states the principles underlying interchangeable production.

1917.—Chubb, I. W., Producing British Screw gages, 1917. (*Amer. Mach.*, vol. 46, pp. 593-594.) Notes relating to the methods followed by E. G. Wrigley & Co., in making gages for munition purposes.

1917.—Cooke, A. G., W. J. Gow and W. G. Tunnicliffe, Manufacture of Gages at the L. C. C. Paddington Technical Institute, 1917. (*Jour. Inst. Mech. Engrs.*, Feb.-March, pp. 45-108.) Workshop details and methods of securing a high degree of mechanical accuracy under conditions of great urgency and without special equipment. Relates to the standardization of munition manufacture. (Abstracts in *Iron Age*, vol. 99, pp. 536-538, and *Model Engr., and Electrician*, vol. 36, p. 115.)

1917.—Crompton, R. E. B., Notes on Screw Gages, 1917. (*Automobile Engr.*, vol. 7, pp. 35-37.) States that at the commencement of the war there was no satisfactory system in use for gage making; suggests that whole series of screws from 3-in. down to the tiny screws should follow one law for tolerances, modified only by considerations of the method of manufacture.

1917.—Dilrell, A. G., Ammunition for American Merchantmen, 1917. (*Amer. Mach.*, vol. 46, pp. 617-625.) Description and illustrations of gages for 6-in. shell for the U. S. Navy.

1917.—Erdman, A. W., Limits and Tolerances for the Manufacture of Munitions, 1917. (*Jour. Amer. Soc. Mech. Engrs.*, vol. 39, pp. 382-384.) Discusses some of the practical aspects of limits and tolerances, as customary applied. (Abstracts in *Amer. Mach.*, vol. 47, pp. 73-74; *Iron Trade Rev.*, vol. 60, pp. 1130, 1139-1140.)

1917.—Erdman, A. W., Limits and Tolerances in Munitions Manufacture, 1917. (*Iron Age*, vol. 99, pp. 1137-1138.) On relation of tolerances to weight; thread tolerances; individual judgment of inspectors; machine-tool limitation.

1917.—Forrest, James, Inspection of Munitions, 1917. (*Amer. Mach.*, vol. 47, pp. 763-764.) Inspection of munition work, and an example of gaging with minimum plug.

1917.—Gage Problem in Rifle Manufacture, 1917. (*Iron Age*, vol. 99, pp. 1199-1200.) States that there are not enough tool makers to equip private plants with fixtures.

1917.—How Gages for Big British Shells Are Made, 1917. (*Iron Trade Rev.*, vol. 61, pp. 17-22.) Describes the plant of Dove-Smith & Son at Niagara Falls.

1917.—Hamilton, Douglas T., Gaging and Inspecting Threads, 1917. (*Machinery*, vol. 23, pp. 477-486, 581-586.) Review of question of manufacturing tolerances on various elements of a screw thread as well as other points of importance.

1917.—Iler, William T., National Supervision of Gages, 1917. (*Machinery*, vol. 23, pp. 961-962.) Shows organization of proposed gage department of U. S. Munitions Board.

1917.—Macintyre, J. R., Production of Accurate Thread Gages, 1917. (*Machinery*, vol. 24, pp. 31-32.) Methods used in making thread-cutting and radius-forming tools and an angle-grinding fixture; current practice in the Remington Arms Co.

1917.—Macready, C. A., Elements of Gage Making, 1917. (*Amer. Mach.*, vol. 47, pp. 491-493, 661-664, 1112-1118.) On the principles and methods for recognizing and avoiding errors that have become habitual to gagemakers.

1917.—Masked Tolerances, 1917. (*Amer. Mach.*, vol. 46, pp. 694-695.) Method followed in making French high-explosive shell.

1917.—Modification of the Whitworth Screw Thread (letter), 1917. (*Engrg.*, vol. 103, p. 385.) Discusses proposals of W. C. Unwin, which are stated to be of interest to those manufacturing munitions.

1917.—Moffett, L. W. Toolmaker's Rôle in Wartime, 1917. (*Iron Trade Rev.*, vol. 60, pp. 929-931.) On the necessity of providing gages, jigs and fixtures for mass production.

1917.—Powell, H. J. Bingham, Inspection of Screw Gages for Munitions of War, 1917. (*Amer. Mach.*, vol. 47, pp. 1065-1073.) An attempt to assist screw-gage manufacturers in their work of making gages for munitions of war, which have to be accurate within very low tolerances.

1917.—Powell, H. J. Bingham, Screw Gage Measuring Machine, 1917. (*Amer. Mach.*, vol. 47, pp. 840-842.) Describes machine similar to one used in gage department of the British Ministry of Munitions.

1917.—Pusep, Hugo F., Practical Points in Flat-Gage Mak-

ing, 1917. (*Amer. Mach.*, vol. 47, pp. 369-372.) It has been demonstrated by all concerns engaged in producing war munitions in large quantities that the gage is an indispensable tool for taking measurements during the manufacture of primers, fuse bodies, time fuses, rifle parts, etc.

1917.—Screw Thread Measurements; Some of the Accurate Methods Used in Gage Making, 1917. (*Iron Age*, vol. 99, pp. 894-895.) Sketches showing definitions adopted for various portions of screw threads; method of measuring screw threads by microscopic micrometer and principle of the optical projection apparatus; in relation to the needs at the beginning of the war, when British manufacturers were compelled to make interchangeable parts in large quantities.

1917.—Sears, J. E., Manufacture of Screw Gages (letter), 1917. (*Engrg.*, vol. 103, p. 137.) On the work of the National Physical Laboratory since commencement of war; pitch measurement, diameter measurements, optical apparatus, automatic lapping of screw threads.

1917.—Standardization of Screw Threads, 1917. (*Engrg.*, vol. 103, p. 360.) A series of questions accompanied by table and drawing of the Whitworth thread, sent out by the Engineering Standards Committee, in coöperation with the Ministry of Munitions.

1917.—"Sponsel" Gun Barrel Calibrating and Straightening Machine, 1917. (*Amer. Mach.*, vol. 47, p. 744.) Describes a machine used for measuring and straightening the bore of gun barrels, etc.

1917.—Starr, Adolph, Special Micrometer for Measuring Cartridge Tools, 1917. (*Amer. Mach.*, vol. 46, pp. 651-652.) Illustration of a micrometer designed for measuring drawing punches for brass shells and covers.

1917.—Suverkrop, E. A., Precision Thread Gages, 1917. (*Amer. Mach.*, vol. 47, pp. 265-271.) Details of making precision thread gages from the bar stock to the finished gage, in its relation to the manufacture of munitions.

1917.—United States Common Shrapnel and Common Steel Shells, 3.8, 4.7 and 6 in., 1917. (*Amer. Mach.*, vol. 46, pp. 1113-1118.) Specifications and operation lists for the different projections shown; includes gaging.

1917.—United States Munitions, the Springfield Model 1903 Service Rifle. (*Amer. Mach.*, vol. 46.) Floor plate, floor-plate catch, magazine spring, pp. 415-426; list of operations on parts that go to make up the magazine, illustrated; gages are included. Making the guard, pp. 287-293, 333-338, sequence of operations, including gaging; illustrations. Making the stock, pp. 1031-1041, 1079-1085, 1123-1129; sequence of operations, including gaging; illustrated. Movable stud; front sight and movable base; guard, gear, trigger and floor plate; leaf; slide and cap; draft slides; windage screw and butt plate, butt-plate cap, upper band, lower band, spring and swivel butt plate swivel, pp. 463-469, 551-558, 595-602, 641-647, 685-690, 725-735, 771-779; sequence of operations, including gagings; illustrated. Movable stud, pp. 463-469; includes illustrations of gages. Oiler and thong case, spare parts, container, screw-driver, pp. 947-953; includes illustrations of pages. Operations on the hand guard, pp. 67-73 (vol. 47), 111-118; list of operations and illustrations of gages used. Operations on the sleeve, pp. 19-27; illustrations of gages are given. Safety-lock spindle and plunger, pp. 245-250; small details requiring several interesting operations; some of the fixtures and gages are of special interest; illustrated. Stacking swivel, hand-guard clip, front-sight cover, cleaning rods, pp. 817-823; list of operations and illustrations, including gaging, of small accessories which go to make up the completed rifle. Striker, mainspring and extractor, extractor collar, ejector and ejector pin, pp. 111-119, 153-161; includes illustrations of gages. The bayonet, pp. 197-205 (vol. 47); show gages used in manufacturing the three kinds of bayonets used by the United States; the knife or regular bayonet and the large and small bolo bayonets. The cocking piece, pp. 69-76; illustrations of gages are given.

1917.—United States Munitions, the 3-Inch Common Shrapnel, 1917. (*Amer. Mach.*, vol. 46, pp. 353-377.) Includes illustrations of gages used.

1917.—United States Munitions, the 3-in. Common Steel Shell, 1917. (*Amer. Mach.*, vol. 46, pp. 486-507.) Includes illustrations of gages used.

1917.—United States Munitions, 3 to 6-in. Cartridge Cases, 1917. (*Amer. Mach.*, vol. 46, pp. 881-903.) Includes illustrations of gages.

1917.—Unwin, W. C., Further Notes on Screw Threads, 1917. (*Engrg.*, vol. 103, p. 289.) A comparison of British Standard Fine Threads (B.S.F.) and the International Metric Thread, which is now largely adopted for munition work in Great Britain.

1917.—Unwin, W. C., Suggested Modification of the Whitworth Screw Thread, 1917. (*Engrg.*, vol. 103, pp. 158-159.) Relating to the production of a great quantity of interchangeable mechanical parts for munitions. The advantage of clearance at the roots and crests of screw threads is examined and the effect of such a modification on the dimensions of the thread. (Abstract, Proposed Modification of Whitworth Thread, in *Iron Age*, vol. 99, p. 930.)

1917.—Van Wyck, J. R., Heat Treatment and Temperature Measuring of Shells, 1917. (*Amer. Mach.*, vol. 47, pp. 1087-1090.) Description of a successful method used in the manufacture of two million 3-in. Russian shrapnel shells.

1917.—Whitaker, E. W., Inspection of Gages for Ammunition, 1917. (*Iron Trade Rev.*, vol. 60, pp. 1242-1243.) The author shows the necessity of systematically checking all munition gages.

1918.—Powell, H. J. Bingham, Inspection of Screw Gages for Munitions of War, 1918. (*Jour. Amer. Soc. Mech. Engrs.*, vol. 40, pp. 108-109.) Discusses the question of pitch in screw gages.

1918.—American Society of Mechanical Engineers, Public Meeting of Gage Committee, culminating in a proposal to the Government to coöperate in munitions contracts by requiring certification of gages by Bureau of Standards, 1918. (*Jour. Amer. Soc. Mech. Engrs.*, vol. 40, pp. 70-72.) Recommends that gages be checked against standards under unified supervision.

MAKING MALLEABLE CAST IRON RIFLE GRENADES. *The Foundry*, vol. 46, no. 2 (whole no. 306), February 1918, pp. 47-56, 22 figs.

MODERN GUN MANUFACTURING PLANT. *The Iron Trade Review*, vol. 62, no. 6, February 7, 1918, pp. 368-372, 15 figs.

MILITARY ENGINEERING, Maj.-Gen. Wm. M. Black. *The Rose Technic*, vol. 27, no. 3, December 1917-January 1918, pp. 72-76.

SMOKELESS RIFLE POWDERS. *Arms and Explosives*, vol. 25, no. 303, December 1, 1917, pp. 158-160.

SCREW-THREAD TOLERANCES FOR MUNITIONS. *American Machinist*, vol. 48, no. 4, January 24, 1918, pp. 135-136, 3 figs., 4 tables.

Power-Plant Engineering

JOLIET POWER PLANT. Description of the power plant of the Public Service Company of Northern Illinois at Joliet, Ill.

The outstanding feature in the new plant is the high steam pressure used, which is 300 lb. at the turbine and approximately 325 lb. at the boiler, superheated 225 deg., or about 75 lb. higher than common in modern stationary practice.

Because of the density of the steam, extra heavy piping of relatively small diameter is used, all rigid construction being carefully avoided. The lengths of straight runs have been limited, and numerous long-radius bends are employed to provide for expansion.

Individual all-steel horizontal-tube economizers are used, said to be the first of their kind in the country. The construction of these economizers is similar to that of the B. & W. water-tube boiler without the drum. The headers are of rod steel and the tubes, which are 4 in. in diameter and 16 ft. long, of drawn steel ¼-in. thick. As low temperatures are expected, the tubes are galvanized inside and out to guard against corrosion. The economizer is vertically paneled for three passes, the gases from the boiler entering at the front, and from the third pass rising vertically through the induced-draft fan to the stack. Although at the given rating the fan requires 94 hp., a 150-hp. motor was installed to provide for contingencies and to reduce upkeep to a minimum. Water to the economizer

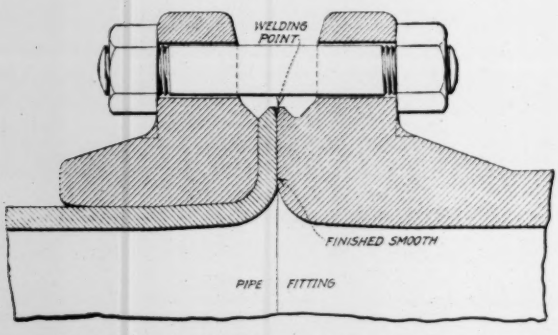


FIG. 6 SPECIAL WELDED JOINT FOR EXTRA HEAVY STEAM PIPING

enters at the bottom of the rear header and passes through 396 four-inch tubes, to leave at the top of the front header.

The economizer is placed above and integral with the boiler, the economizer tubes having a 5-deg. slope. There are no dampers between, so that the gases pass directly from one to the other, the furnace gases flowing from the economizers at such low temperatures as to permit unlined steel stacks.

Outside of the small stoker engines held as reserves for motor drives there is no reciprocating machinery in the station. With little exhaust steam available to heat the feedwater, provision is made to bleed steam under thermostatic control from the fourth stage of the main turbine, where the pressure is sufficient for this purpose. Another feature is to utilize the condenser for drawing boiler make-up from the fresh-water reservoir. The water enters the condenser, and with the air of the condensate pump is passed in the usual way to the heater.

Extra high high-pressure piping is used throughout with fittings of cast or forged steel. On steel pipes above 4 in. in diameter a special welded joint, shown in Fig. 6, is used. The pipe is extended through the flange and is belled out to form the face of the joint. The face is finished smooth and the edge beveled off to form a V-shaped groove to receive the welding metal. On fittings a face boss of extra thickness to form a welding surface similar to that in the pipe flange is provided. The weld is intended only to seal the joint, the bolts through the flange taking this stress. (*Power*, vol. 47, no. 4, January 22, 1918, pp. 108-113, 7 figs., *d*)

POWER PLANT INSTALLATIONS FOR BY-PRODUCT COKE OVEN PLANTS, George B. Evans. *Journal of The Engineers' Club of St. Louis*, vol. 2, no. 6, November-December, 1917, pp. 321-327.

Railroad Engineering

ALL-WOOD AND COMPOSITE HOPPER CARS FOR THE NORFOLK & WESTERN RAILWAY. B. W. Kedel. Description of two recent designs of hopper cars. The Norfolk & Western Railway is just beginning the construction of an order of 2000 hopper cars of 57½ tons capacity, ten of which are being built entirely of wood, including the center sills and bolsters, for demonstrating the possibility of this construction for cars of such capacity. The rest will have steel center sills and steel bolsters with wood-frame construction for the remainder of the car.

The design of the all-wood cars is the result of the unusual steel market. The wood and center-sill members consist of a pair of through 6 by 12-in. sills spaced 15½ in. apart, the bottom being located 2 ft. 6 7/8 in. above the rail, or 5 1/8 in. below the center line of the coupler, about as steel sills are ordinarily located and without the old-style draft chambers. Doweled to the inside of each of these along the bottom edge is a buffing sill of 4 by 8-in. dimension, these being consequently located almost symmetrically with the center line of the coupler and extending from one bolster to the other. Bolted between the main center sills over each truck is a gray-iron casting, which serves as a draft-gear backstop and the center channel tie casting, the center plate being cast integral with it and 4 by 8-in. buffing sills abutting on one of these castings at each end. This casting has shelf portions which underlie the main draft sills and support them independently of the bolts. The casting also has bracket portions which overlie the center sills and to these the sills are also hung by means of vertical bolts. Buffing forces are delivered to the draft by this casting and from it to the end grain of the buffing sills, and the buffing sills, in the same manner, transmit the force directly to the draft gear at the opposite end of the car and on to the next car.

The body of the car is anchored to the main 3 by 6-in. draft sills and these are bolted and doweled at intervals to the buffing sills to take care of the shifting of the body and the lading with respect to the buffing sills. The center plate being integral with the back-stop casting, the force from the inertia of the truck in buffing reacts at one end of the car against the ends of the buffing sills and at the other end of the car directly against the draft gear through this casting. The retarding force of a brake application is transmitted in the same manner.

The bolsters are each composed of two 6 by 20-in. yellow-pine timbers passing over the center sills and beneath the hopper chute, and these rest upon the top surface of the gray-iron center casting.

The design of the composite cars does not represent anything of unusual novelty. It is, however, of interest to note that iron castings are used quite extensively in the framing of these cars, the weight of the car being not much higher, however, than that of a steel car of equal proportions. (The first car turned out weighs 42,300 lb.)

It was contemplated on the steel center-sill cars to use wooden bolsters with the steel center sills, but because of the difficulty of making steel and wood work together with beam construction, steel bolsters are used with steel sills. The deflection of wooden beams is such that the center sills would be greately overstrained over the center plate before the bolster would have its proper load. Also the shrinkage of wood against the constant dimension of the steel would probably cause such variations in the loading at points as to entirely defeat the design. (*Railway Review*, vol. 62, no. 1, January 5, 1918, pp. 13-15, 2 figs., *d*)

RAIL CREEP. In a paper by Frank Reeves are described some simple experiments having for their purpose an explanation of the so-called creeping of rails. The broad conclusions at which the author arrived are: Creep of rails is due primarily to the deformation of the rail as the wheel passes over it. It may be likened to the movement of dough when rolled under a rolling pin. The more violent the deformation, the greater the creep. That is to say, creep is increased by (*a*) increasing the wheel load, and (*b*) by diminishing the rigidity of the rail, either by reducing its section or using a weaker material.

In a second paper, by Harry Powell Miles, are described briefly the effects which the direction and class of traffic and the alignments and gradients of the line have in producing creeping. The effect which creeping rails have on the constituent of the permanent way and the method of rectifying the positions of the rails after a creep has taken place are described, as well as investigations which the author made for a period of five years on a length of line consisting of 850 track miles of main and branch lines over which various kinds of traffic passed. The results of the investigation are not reported in the article. (*The Railway Gazette*, vol. 28, no. 2, January 11, 1918, pp. 42-45, 6 figs.)

THE EFFECTS OF WATER SCOOPING ON TRAIN RESISTANCES, H. C. Webster. During its passage through the trough the scoop becomes a moving vane and is governed by the same principles as an ordinary turbine, except that the impact in the former case is caused by the collision of the moving scoop against the stationary volume of water and in the latter case by the moving water against the stationary or slowly moving vane.

Assuming that the scoop is moving at a velocity of V ft. per sec., and the area of the delivery pipe is a sq. in., then the resultant reaction of the scoop which constitutes the increased resistance of the train is

$$R = \sqrt{2} \times 62.4aV/144g\sqrt{(V^2/2)}$$

The writer gives the following table for trains moving with velocities between 25 and 60 miles per hour with a equal to 50 sq. in.:

Speed, m.p.h.	25	30	35	40	45	50	55	60
Resistance, lb.	901	1310	1779	2330	2940	3610	4320	5220

The relation between resistance and delivery-pipe area a is shown in the following table ($V = 40$ miles per hour):

a, sq. in.	35	40	45	50	55	60	65	70
Resistance, lb.	1631	1860	2100	2320	2560	2800	3040	3260

If these data are plotted as a curve, as the writer does in the original article, a straight line is obtained which shows that in designing the scoop the minimum area is desirable consistent with the volume of water to be lifted over a given length of trough. (*Railway Engineer*, vol. 39, no. 456, January 1918, p. 4, 3 figs., *t*)

LOCOMOTIVE FEEDWATER HEATING. Description of a new system for preheating the water before it is admitted to the boiler of a locomotive. In this case exhaust steam taken directly from the steam chest or the exhaust passage in the cylinder saddle is used. It is claimed that the amount of exhaust steam taken in this way is not sufficient to interfere materially with the draft of the locomotive, while the feedwater temperature is raised from 150 to 180 deg.

With this system the injector is replaced by a new water pump which was developed for this particular work by the Westinghouse Air Brake Company.

This pump was modeled after a Westinghouse compressor. The steam end is that used on a standard 9½-in. compressor. The water cylinder is 6½ in. in diameter and double-acting. Tests made with this pump have shown that 50 lb. of water are pumped per lb. of steam used for operating the pump.

In the heater illustrated in the original article the exhaust steam from the steam chests is admitted at the top, allowed to circulate around the tubes which contain the feedwater, and passes out through the drain at the bottom. The water from the pump passes through the heater four times before it is delivered to the boiler. This is accomplished by means of walls in the headers at the end of the heater. One of the headers has three chambers formed by a wall extending horizontally across the header at the center and a vertical wall extending up from this wall. The other header has one vertical wall dividing it into two parts.

One of the most important features of this heater is represented by the agitators contained in each of the tubes in the heater. They consist of thin corrugated and spiraled strips of brass and their function is to so agitate the water as it passes through the tubes that every particle of it will come in contact with the hot tubes and absorb all the heat possible from the exhaust steam on the outside of the tubes. This agitation also serves to keep the tubes clean and free from scale. The higher the velocity of the cold water passing through the tubes, the more violent the agitation and the greater the amount of heat absorbed by the water. (*Railway Age*, vol. 64, no. 3, January 18, 1918, pp. 177-179, 3 figs., *d*)

THE CREEP OF RAILS, Frank Reeves. *Engineering*, vol. 105, no. 2716, January 18, 1918, p. 66.

SOLIDIFICATION AS A FACTOR IN RAILWAY VALUATION, H. M. Taylor. Discussion of methods for determining the value of "the hardening down" of a railroad, which means depreciation in the roadbed due to seasoning. The writer believes that it would be possible to arrive at a factor for determining closely the value of solidification by investigating the large companies which have lines long in service and lines newly built. (*Railway Age*, vol. 64, no. 3, January 18, 1918, pp. 176-179, 5 figs.)

Steam Engineering

AIR PUMPS. A sub-committee appointed by the Council of the North-East Coast Institution of Engineers and Shipbuilders recently presented its report on various methods of producing high vacuum.

This report was based on an investigation carried out at the works of Richardsons, Westgarth & Co., at West Hartlepool, England. The apparatus used in the investigations is of the composite type, such as used in college laboratories. It is shown diagrammatically in Fig. 7.

The tests were made on reciprocating air pumps working all wet, wet and dry, etc., and two steam jets. The pumps were

not used with the condenser, but with the receiver *A*. Into this receiver continuous streams of air and hot water to represent the condensate could flow at known rates, and it was the duty of the pumps to remove the water and maintain the vacuum in the receiver by withdrawing the air and vapor. As it was found in early tests that the aeration of the water was very irregular, it was decided to standardize it and for this purpose the de-aerator *C* was installed. It consists of a chamber exhausted by a steam jet to a vacuum of about 24 or 25 in.

The first tests were made with the plant arranged on the "ordinary wet system" with both barrels working. The results are shown at *A*, *B* and *C* in Fig. 8. To study the effect of the reduction in the volume of air, tests were then made

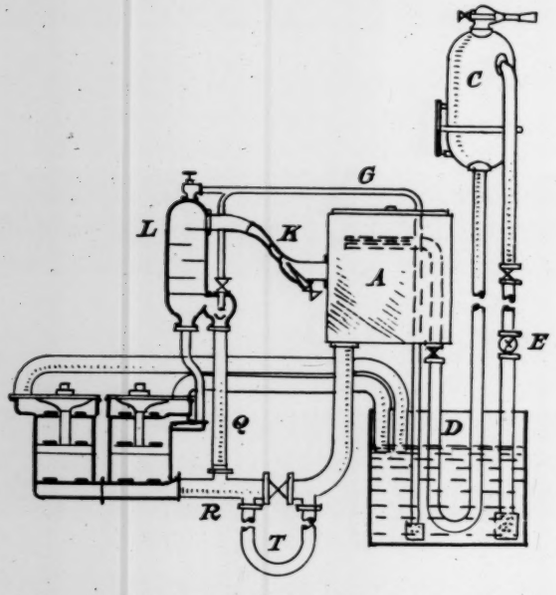


FIG. 7 DIAGRAM OF EXPERIMENTAL APPARATUS

with the single barrel, the results being shown in *D*. The next experiments were carried out with one barrel working wet and the other dry. The results obtained are shown at *E*, with cooling water at 50 deg. fahr., and *F*, cooling water at 70 deg. fahr.

Next "kinetic" combinations were tried out. Fig. 7 shows the connections used for the kinetic twin wet system. Two ¼-in. steam jets working in parallel were fitted at *K*. The air withdrawn by these jets from the receiver was discharged into the small receiver and condenser *L*, the water being directed through the U-pipe *T*, which acted as a seal, making effective the head obtained by the height of the receiver above the foot valves and so preventing the passage back to the receiver of the air and vapor in pipes *Q* and *R* already compressed by the action of the steam jet. The results obtained are shown in *G*, for 60,000 lb. of condensate per hour, and *H*, for 10,000 lb. of condensate per hour.

The report states that the advantage obtained by the use of the jet is at once apparent, the vacuum approaching very closely to that ideally obtained in the absence of air, and an important portion of the curve being indistinguishable therefrom.

Two other arrangements of the kinetic system, namely, the kinetic wet and dry, were tried. The jet *K*, Fig. 7, and its condenser were moved to the left and connected with the barrel on that side and the U-pipe *T* was dispensed with. The right-hand barrel was run wet and the left-hand barrel dry. The line *K*, Fig. 8, shows the results obtained.

The tests have shown the greater efficiency of the steam jet. The complete report can be obtained from the Institution and costs half a guinea. (*The Engineer*, vol. 124, no. 3235, December 28, 1917, p. 557, 4 figs., *e*)

AIR PUMPS AND CONDENSERS. A new application of the steam-jet vacuum has recently been suggested by D. B. Morison. An extended investigation brought him to the conclusion that the steam jet is of advantage where the conditions are such that a poor vacuum meets the needs of the case. From his experience it appears that if a 25-in. or 26-in. vacuum will satisfy requirements, it can be obtained more cheaply and maintained more certainly by the use of auxiliary steam jets than in any other way.

A bad vacuum in a condenser, if not due to dirty tubes or hot cooling water, implies that much of the tubing is air-jacketed. In the commercial operation of reciprocating engines it is difficult to prevent air leakage, which impairs the efficiency of the condenser tubing. As the mixture of steam and air passes over the tubes, the steam as it condenses drops away as water, but the air remains behind, jacketing the tube. As a result, the lower rows of tubes in a reciprocating-engine condenser become quite ineffective.

Nevertheless, the lower rows cannot be abolished, because the air pumps can only remove a certain volume of air per minute, depending on their gross piston displacement, and also on the temperature and pressure of the air itself. If the lower tubing be removed, the air will be delivered to the pumps at a higher temperature, and in that case either the piston displacement must be increased or the air must be delivered to the pump at a higher pressure, which means a worse vacuum in the condenser.

Here is to be found the advantage of the steam jet. If steam jets be interposed between the condenser and the pump, these jets which have a great volumetric capacity compress the

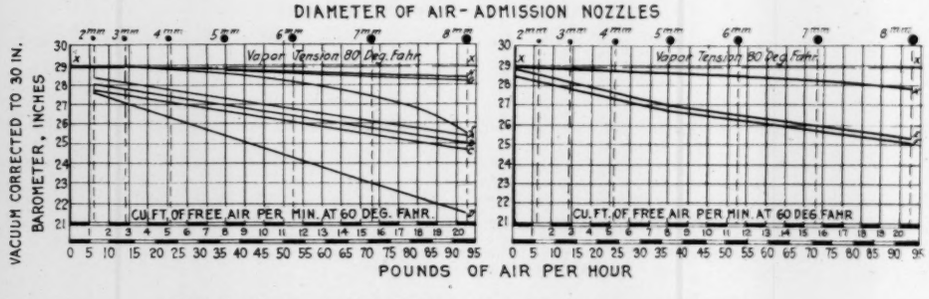

DIAMETER OF AIR-ADMISSION NOZZLES
2mm 3mm 4mm 5mm 6mm 7mm 8mm
Vapor Tension 80 Deg. Fahr.
VACUUM CORRECTED TO 30 IN. BAROMETER, INCHES
CU. FT. OF FREE AIR PER MIN. AT 60 DEG. FAHR.
POUNDS OF AIR PER HOUR

FIG. 8 DATA OF WEST HARTLEPOOL TESTS OF AIR PUMPS

air into the pump suctions, so that a large weight of air can be abstracted with a very moderate pump displacement. Hence, the amount of the cooling surface in the condenser can be reduced 20 to 25 per cent, and the air pumps may also be made much smaller.

The experiments referred to in this article are those made by a sub-committee of the North-East Coast Institution of Engineers and Shipbuilders, and are reported in the next abstract. (*Engineering*, vol. 104, no. 2712, December 21, 1917, pp. 664-665, 2 figs., *e*)

MEASURING, PURIFYING AND HEATING FEED WATER, AND FEEDING BOILERS. *Southern Engineer*, vol. 28, no. 5, January 1918, pp. 52-74, 36 figs.

CONDENSERS WITH SEVENTY-FOOT WATER LEVEL VARIATION, F. R. Brosius. Description of an installation where a type of substructure construction had to be adopted so as to insure a satisfactory supply of condensing water under unfavorable conditions and also support the great weight of the building and equipment on unstable ground. There are five condenser wells, with the intake well 86 ft. deep from the basement floor to the well floor and 60 ft. in inside diameter. Special methods for sinking the three larger wells had to be resorted to. It is of interest to note that part of the weight of the turbine rim rests on these wells. (*Power*, vol. 47, no. 5, January 29, 1918, pp. 142-144.)

THE LUBRICATION OF STEAM TURBINES. *Power*, vol. 47, no. 6, February 5, 1918, pp. 198-201, 3 figs.

AGRICULTURAL TRACTORS, Alan E. L. Chorlton. *Engineering*, vol. 105, no. 2714, January 4, 1918, pp. 7-10, 10 figs. Among other things, the subjects of drawbar pull and road resistance are discussed in detail in a very interesting manner.

Varia

AMERICAN RESEARCH METHODS, Charles H. McDowell. *Journal of the Western Society of Engineers*, vol. 22, no. 8, October 1917, pp. 546-564.

AN INDUSTRIAL ACHIEVEMENT OF THE WAR, L. P. Alford. *Industrial Management*, vol. 55, no. 2, February 1918, pp. 97-100, 1 chart.

WOMEN IN AIRPLANE PRODUCTION, I. William Chubb. *American Machinist*, vol. 48, no. 6, February 7, 1918, pp. 221-225, 16 figs.

LAWS REGULATING WOMEN IN SHOPS. *American Machinist*, vol. 48, no. 6, February 7, 1918, pp. 239-240.

WOMEN AS FOUNDRY WORKERS IN GERMANY, K. Abeking. *The Metal Industry*, vol. 11, no. 25, December 21, 1917, pp. 520-523, 4 figs.

Charts

CHARTS FOR DRAWING WHITWORTH HEXAGONAL NUTS. *Mechanical World*, vol. 63, no. 1619, January 11, 1918, p. 15.

GRAPHIC METHOD OF DETERMINING THE AMOUNT OF RADIATION REQUIRED, M. William Ehrlich. *Power*, vol. 47, no. 7, February 12, 1918, p. 225.

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society. The Editor will be pleased to receive inquiries for further information in connection with articles reported in the Survey.

LIBRARY NOTES AND BOOK REVIEWS

ARTICLES of interest from the Library of the four Founder Societies, selected list of accessions during the month, and reviews of books of special importance prepared by members of the A.S.M.E. and others particularly qualified.

Making the Library Serve Your Purpose

IT is only by constant use that one begins to understand and appreciate into what an immense storehouse of knowledge the combined engineering societies' Library has now developed. For although a complete dictionary catalogue by authors and subjects may be available, and in addition many published bibliographies besides those compiled in the Library—all of which are at all times at the disposal of members visiting the Library—it would be a mistake to think that this machinery affords complete access to all the material.

Complete access could only be provided by a systematic index covering the whole of the books and periodicals, and such an index would hardly consist of less than twenty million cards, to approach anything like completeness; but the cost of this work is far beyond the present financial resources of the Library.

It is evident that a dictionary catalogue and bibliographies merely act as principal signposts through the labyrinth of knowledge constituted by the publications. But although no complete index is available, the Library possesses other means to get at what is wanted, i.e., a staff of searchers, who from long experience have learned to dig, and to dig deeply; and it is now a rare thing that a question is presented for elucidation and the inquirer is not satisfied. These searchers, making use of the signposts mentioned, act as guides in the innumerable directions indicated; it is they who finally obtain whatever information may be required.

Members of the engineering societies are at all times welcome in the Library, and welcome also to do their own digging, in which the Library staff will gladly assist them; but they will find that as a rule it is cheaper and much more convenient to have the digging done for them, for an experienced searcher will find a dozen references where an inexperienced man will find one.

Bibliographical work done by the searchers may serve a variety of purposes. It may be used for direct application in business; as a basis for technical papers, books, lectures; as a basis for inventions and patents; as a basis for legal action; or from the standpoint of economic, financial, and other aspects. It is therefore of the utmost importance that

all questions made the object of a search should be stated with the greatest accuracy, for only an intelligent question is likely to elicit an intelligent answer. In the great majority of cases it is unwise to ask the Library for all information on a given subject. In almost every case it is necessary to state limitations, such as: The search is to cover a stated number of years; the information is required for such and such a purpose; patents must be included or excluded, etc.; and this is the more necessary because it is generally in the more difficult questions that the assistance of the Library is required.

In view of the multitudinous ramifications of search work it is hardly possible to apply standardized methods to it, but it may be explained that the usual procedure includes the following steps:

a The inquiry is formulated exactly; if this is impossible, further information is asked of the inquirer.

b A bibliography is made to cover the subject exactly as stated, and is submitted to the inquirer.

c After perusal the inquirer may decide either to examine all the material or to select for further consideration such references as appear to him most suitable.

d In accordance with his decision the Library may be called upon to make photoprints, translations, or abstracts of the material selected, as the case may be.

e On receipt of these the inquirer is in a position to give the final answer to the original question, or he may determine in what further directions the assistance of the Library would be desirable.

Of course, the inquirer is at liberty to close the question at any of the stages enumerated. The Library also will tell the inquirer quite frankly when searching has probably reached the limits of usefulness, and it keeps an exact record of the extent of the searches made, so that any one may be continued at any time without duplication of the work.

An examination of the searches made in the Library would open the eyes of many as to the variety of subjects of inquiry. Although the searches are made under definite instructions from the Director with regard to methods, sometimes a question is received the answer to which lies entirely outside of the recognized routine, and to find an answer to some of these may tax to the utmost the ingenuity of the searchers. The following is an instructive example:

Some time ago a member presented the following question: "About fifteen to twenty years ago the sulphur beds of the island of Saba were worked; find the references."

In a case like this the card catalogues and most of the printed indexes are of little use, for even the encyclopedias dismiss a small place like Saba with a perfunctory note of about five or six lines, stating that it is a small island belonging to the Dutch West Indies, etc. The searcher experiences a vivid realization of the hopeless position of a man standing before a mass of books and not knowing where to attack them.

Reflection shows that the only way to attack such questions is to analyze them and think out a plan leading to the desired information. Thus in the Saba case the population would be very small and, therefore, mining operations of any extent would very likely be reflected in the figures. Again, the ore mined would presumably be exported, and being a poor ore by inference (for otherwise operations would be still going on), it could not stand the freight rate to Holland; it would most likely be shipped to the United States, also on account of geographical location and shipping facilities. Thus we obtain two sets of figures, population and imports to U. S., with which to begin operations. Which of these two sets is more likely to be available, to be more accessible and more accurate? Experience teaches that as a rule population figures are more reliable and more easily accessible, hence these were made the point of attack.

After considerable trouble, sufficient figures were obtained between the years of 1886 and 1913 to construct a curve, showing that a peak occurred about the year 1888. This was followed by a continuous decline, but preceded by rather small variations. Figures before 1886 could not be located, although it would have been interesting to follow out the variations indicated. Assuming that the year 1888, the peak of the reconstructed curve, was the year of the mining operations in question, this would agree fairly with the statement of the inquirer that they took place fifteen to twenty years ago, for in almost every case the time given is understated. The obvious course to follow now was, therefore, to examine the figures giving the imports into the United States for the corresponding period. Naturally, no geographical figures were available for a small place like Saba, the only statistics found including all the Dutch West Indies and Surinam; as for the subject sulphur, it was useless to think of tracing it in the imports.

The tables of imports found, however, proved to be disappointing, for they showed no unusual features; there was no peak corresponding to that of the population, nor was it perhaps reasonable to expect such an indication in view of the complexity of the figures.

According to the population curve it was useless to examine import figures for later years, so it was decided to work backwards at any rate to 1880, for there a decennial table for 1870-80 might be found. So it turned out to be, and the figures for 1875 indicated a fairly large import. What was more remarkable still, this import figure was isolated—it was preceded and followed by entire absence of imports. Although this absence might be satisfactorily explained in various ways, this was a good-enough indication on which to refer to mining magazines of that year in the hope of finding Saba, and so it happened. The article giving the information was found in the *Engineering and Mining Journal* for July 1875, vol. 20, p. 56.

It may be argued that going through the mining magazines at once would have led to the desired result, but in view of the fact that the inquirer was 22 years out in his statement, the fallacy of this is obvious. Besides, searching indexes for a number of years back has its difficulties; one is forcefully reminded of the philosopher's dictum, "Nothing is constant but change."

In the above case the train of thought led to the desired result; it might also have failed, but it is a fair example to show that no pains are spared in the Library to get at the information desired by members. Nor should the charge made by the Library for this class of work deter members from the full benefit of this unique collection of engineering literature, for the rate of $1.50 per hour charged is calculated to cover actual cost, so that no part of it will fall on the finances of the Library.

Inquiries from members are at all times welcome and estimates for work required will be gladly given so far as this is possible. Members who send orders to the Library can always keep control of the work to the extent of specifying the number of hours to be spent on their inquiries.

J. K.

BOOK REVIEWS

Machinery's Encyclopedia. A Work of Reference Covering Practical Mathematics and Mechanics, Machine Design, Machine Construction and Operation, Electrical, Gas, Hydraulic and Steam Power Machinery, Metallurgy and Kindred Subjects in the Engineering Field. Compiled and edited by Erik Oberg and Franklin D. Jones, in collaboration with many prominent mechanical and electrical engineers. The Industrial Press, New York, 1917. In 7 volumes, half-leather, 8x11 in. $36.

In spite of the unquestioned usefulness of encyclopedias of engineering, the English language is, unfortunately, poorly equipped with these summaries of current practice at the time. Such works as Spon's Dictionary of Engineering and Appleton's Cyclopedia of Applied Mechanics had great practical value in their day, as epitomes which saved reference to many individual treatises, but the time that has elapsed since their issuance has made them obsolete and created a need for some successor which would present present knowledge and current practice in concise and authoritative fashion.

The present work is intended to do this for mechanical engineers, especially for those interested in the design, construction and operation of machines and machine tools. To this end particular attention has been given to those processes and methods which the designer and manufacturer of machine tools use and to the best practice in machine-shop operation. The material included has been selected from the standard treatises and from the columns of *Machinery;* supplemented by numerous special signed articles on many phases of the general subject.

The noticeable features of these volumes are the length of the articles on important topics, the liberality with which they are illustrated, and the care that has been taken to include topics that are usually given scant attention. The article on Broaching, to take an example at random, fills 9 pages and contains 17 illustrations. Twenty-two pages are given to a discussion of Assembling. The question of Grinding and Grinding Machines occupies 50 pages, while the article on Autogenous and Electric Welding is 30 pages long. These articles give an idea of the scope of the work; the minor articles, however, are also useful, including as they do much material that usually is hard to find.

The final volume includes a comprehensive index, enabling one to find information not brought out by specific headings in the encyclopedia, and a Guide to Systematic Reading, outlining courses of orderly study on a number of topics, such as Mathematics, Forging Practice and Equipment, Finishing and Protecting Metal Surfaces, etc.

The mechanical construction of the set is good. The type, while small, is clear. The illustrations are reproduced from line drawings and are really illustrative. The pages open flat.

The producers of the work are to be congratulated upon the result of their endeavors. The set will prove of distinct usefulness in any library of engineering.

HARRISON W. CRAVER.

The Principles of Iron Founding. By Richard Moldenke, E.M., Ph.D. McGraw-Hill Book Co., Inc., New York, 1917. First Edition. Cloth, 6x9 in., 517 pp., 45 illustrations. $4.

Dr. Moldenke needs no introduction to those familiar with foundry practice, for he is one of the comparatively few men who have had to do with the marked advance of recent years in the art of producing sound castings. He is not only a well-trained technical man, but a successful foundryman as well, having had at different times the management of some of the largest foundries in this country producing gray iron, malleable and steel castings.

His fifteen years of acceptable service as secretary of the American Foundrymen's Association have brought him into close touch with all of the prominent founders of the world and provided the best possible training for writing a book on foundry work.

The author has undertaken to deal more or less completely with all of the principles underlying the processes involved in the art of iron founding.

It is rather unfortunate that there is nothing in the title to indicate that the author has not covered the whole field in his book. Either the title should be changed or this book should be marked Vol. 1, for the author notes that he is now at work on a second volume which will deal more particularly with general foundry practice.

This volume pays especial attention to the metal itself, to melting processes and to mixture making, and leaves nothing to be desired in the way of general information along these lines.

The problem of oxidized iron is given special attention and much new material is presented.

The book together with the promised second volume will unquestionably become the leading reference book on foundry practice and can be safely recommended to those seeking information on foundry work along either historical, scientific or practical lines.

The book should be in the library of all those interested in foundry work, as it is well worth owning. The facts and information which it presents are absolutely reliable and no other foundry book contains so much that is so.

WILLIAM W. BIRD.

Lubricating Engineer's Handbook. A Reference Book of Data, Tables and General Information for the Use of Lubricating Engineers, Oil Salesmen, Operating Engineers, Mill and Power Plant Superintendents, Machinery Designers, etc. By John Rome Battle, B. S. in M. E. J. B. Lippincott Co., Philadelphia, 1916. Cloth, 6 x 9 in., 333 pp., 114 illustrations and 16 pp. of ruled log sheets. $4 net.

Of very real importance are the 26 chapters devoted to the presentation of specific recommendations as to the proper and economic lubrication of air compressors, automobiles, internal-combustion engines, steam engines and turbines, refrigerating machinery, street and railway cars, locomotives, elevators, rolling-mill, textile, flour-milling and electrical machinery, etc. Wire-drawing and cutting-tool lubrication are also dealt with and chapters are given on lubricating oil and grease tests, lubricants and their properties, the cost of lubrication, etc. The book is self-contained, in that all of the mechanical reference data and tables required in working out lubricating problems are included. The author has been the mechanical engineer of a large oil company for many years and writes with the knowledge thus acquired.

Bulletin No. 99 of the University of Illinois Engineering Experiment Station contains the results of a series of experiments on the collapse of short thin tubes, made by Prof. A. P. Carman of the department of physics. The purpose of these tests was to find an equation by the application of which the pressure required to collapse a tube can be calculated when the dimensions of the tube and the elastic properties of the material are known. The bulletin gives a brief summary of earlier experiments on collapsing pressure, such as those of Fairbairn, Stewart and others, together with the formulæ developed by these investigators. Copies of this bulletin may be obtained gratis by addressing the Engineering Experiment Station, Urbana, Ill.